

**AMBIENT AIR SURVEY
IN THE AREAS OF
THUNDER BAY, RED ROCK,
MARATHON AND TERRACE BAY - 1978**

ARB-TDA Report No. 47-80

PUBLISHED MARCH, 1981

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883.7
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1981



**Ministry
of the
Environment**

The Honourable
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Minister

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Deputy Minister

Air Resources Branch
Technology Development and Appraisal Section
Monitoring and Instrumentation Development Unit

ARB-TDA Report No. 47 - 80

Ambient Air Survey in the Areas of
Thunder Bay, Red Rock, Marathon and
Terrace Bay - 1978

Ontario Ministry of
the Environment,
880 Bay Street,
Toronto, Ontario.

August, 1980.

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01 Summary

As requested by the Northwest Region, an ambient air survey in the areas of Thunder Bay, Red Rock, Marathon and Terrace Bay was conducted by the Monitoring and Instrumentation Development Unit. This survey was carried out during the period of July 31 to September 13, 1978.

The main purpose of this survey was to determine the ground level concentrations of total reduced sulphur (expressed as hydrogen sulphide) and sulphur dioxide in the vicinities of the kraft and sulphite pulp mills located in these centres. The sources under investigation were: Great Lakes Forest Products Limited (Thunder Bay - formerly Great Lakes Paper Company Limited); Domtar Packaging Limited (Red Rock); American Can Canada Inc. (Marathon - formerly American Can of Canada Limited); and Kimberly-Clark of Canada Limited (Terrace Bay).

During the survey period, approximately eight major frontal systems passed through the Great Lakes area, two of which were quasistationary, thus accounting for the majority of the incumbent weather.

Since this ambient air survey dealt mainly with monitoring in the vicinity of pulp and paper mills, sulphur dioxide and total reduced sulphur could, in general, be attributable to single, discrete sources. Therefore the 30-minute average ground level concentration values of these contaminants were investigated and compared to their respective Standards. Two other contaminants of interest were nitrogen dioxide and ozone, of which low ground level concentrations were generally found. Long range mass transport or multi-source contribution were assumed to be the major contributors and hence, the one-hour averages of nitrogen dioxide and ozone were examined and compared to their respective ambient air quality Criteria. Other pollutants monitored and recorded for a regional data base were total hydrocarbons and carbon monoxide.

Over 584 hours of data acquired during 80 different monitoring periods were collected during the entire survey. Of this total time, approximately 468 hours of

monitoring were done in the Thunder Bay area. During this time, the Guideline for total reduced sulphur (0.027 parts per million-ppm) was attained or exceeded for a total of 8½ hours (approximately 2% of the total time). The overall average ground level concentration of total reduced sulphur was 0.007 ppm with an associated standard deviation 0.011 ppm. The maximum 30-minute average ground level concentration was 0.07 ppm, recorded during the monitoring period Thunder Bay #16 on August 7. A wind/concentration rose analysis done for this period clearly points to the Great Lakes Forest Products company as being the major source.

Low concentrations of sulphur dioxide were detected in the Thunder Bay area. From the 451 hours of monitored sulphur dioxide data, the 30-minute Standard (0.30 ppm) was never exceeded. The overall average ground level concentration and respective standard deviation were 0.006 ppm and 0.005 ppm.

The Great Lakes Forest Products company was not a suspected source of either ozone or nitrogen dioxide. Low concentrations for both of these contaminants were detected and their respective Criterion was never exceeded. The largest maximum 60-minute average nitrogen dioxide and ozone ground level concentrations were 0.107 ppm and 0.082 ppm respectively. Correlation analyses between NO_2 and H_2S depicted no mutual origin. For 29 degrees of freedom, a correlation coefficient of -0.35 was determined for these two contaminants.

Over 41 hours of ambient air monitoring was carried out in Red Rock. Approximately 10% of the acquired data for total reduced sulphur resulted in 30-minute average ground level concentrations in excess of the Guideline. The overall average ground level concentration was 0.012 ppm with an associated standard deviation 0.007 ppm. The maximum 30-minute average concentration was 0.13 ppm, recorded on August 27, during monitoring period Red Rock #5. Due to the formation of a vertical flow cell (resulting from an orographic lift and an approaching warm front), entrainment of pollutants from the Domtar kraft pulp mill trapped the emissions in downtown Red Rock. Wind/concentration analyses done on monitoring periods Red Rock #3 and #5 show this feature.

Low concentrations of sulphur dioxide were found in the Red Rock area. The

overall average ground level concentration and standard deviation were 0.003 ppm and 0.001 ppm respectively.

Low concentrations of ozone and nitrogen dioxide were also monitored in Red Rock. The respective Criterion for these two contaminants was never exceeded as the largest maximum 60-minute average oxide and nitrogen dioxide ground level concentrations were 0.032 ppm and 0.064 ppm.

While monitoring in Marathon, over 35 hours of data were acquired. During approximately 25% of this time, ground level concentrations of total reduced sulphur were recorded above the Guideline (0.027 ppm). The overall average ground level concentration was 0.019 ppm with an associated standard deviation 0.007 ppm. The maximum 30-minute average ground level concentration of total reduced sulphur was 0.073 ppm and was recorded on August 29 in downtown Marathon (monitoring period Marathon #4). The wind/concentration rose analysis for this period clearly denotes the American Can Canada Inc. kraft pulp mill as being the major source of this contaminant. Further evidence of the source being this pulp mill was acquired by wind/concentration rose for monitoring period Marathon #6.

The ground level concentrations of sulphur dioxide in Marathon were found to be low. The overall average concentration and respective standard deviation were 0.018 ppm and 0.006 ppm. Although the concentrations of sulphur dioxide were low, their origin was traced to the American Can Canada Inc. kraft pulp mill by the correlation plots done for monitoring periods Marathon #4 and #6. The correlation coefficients, (0.81 and 0.82 respectively), for sulphur dioxide versus total reduced sulphur were found to be significant at the 99.9% confidence level.

The 60-minute average ground level concentrations for nitrogen dioxide and for ozone were, in general, low. Their respective Criteria were not exceeded during the 35 hours of monitoring in Marathon as the maximum 60-minute average nitrogen dioxide and oxide ground level concentrations were 0.027 ppm and 0.040 ppm respectively.

Approximately 39 hours of data were acquired by the mobile air monitoring unit in the vicinity of the Kimberly-Clark of Canada kraft pulp mill, near Terrace

Bay. Significant ground level concentrations of total reduced sulphur were detected. The overall average concentration and associated standard deviation were 0.024 ppm and 0.032 ppm respectively. Approximately 6 hours of data (20%) resulted in concentrations in excess of the 30-minute Guideline (0.027 ppm). While monitoring downwind of the kraft pulp mill, the maximum 30-minute average ground level concentration recorded was 0.30 ppm, near the clarifier and settling pond on September 1st. A wind/concentration rose done for this monitoring period (Terrace Bay #3) clearly points to the Kimberly-Clark mill as the major source of this contaminant.

Relatively low concentrations of sulphur dioxide were detected in Terrace Bay. The overall average ground level concentration was 0.009 ppm with an associated standard deviation 0.004 ppm. Correlation analyses between sulphur dioxide and total reduced sulphur implied a mutual origin. These analyses were carried out for monitoring periods Terrace Bay #1 and #3 and the correlation coefficients were 0.90 and 0.73 with 69 and 53 degrees of freedom respectively. These results were highly significant at the 99% confidence level.

Again low ground level concentrations of nitrogen dioxide were monitored in the Terrace Bay area. The 60-minute nitrogen dioxide Criterion was never exceeded as the maximum 60-minute average concentration was 0.068 ppm.

Background concentrations of ozone were detected in Terrace Bay. The overall average ground level concentration was 0.036 ppm with an associated standard deviation 0.016 and the largest maximum 60-minute average ground level concentration was 0.053 ppm..

As well as monitoring of the gaseous pollutants, five standard hi-volume

samplers (with glass-fibre filters) were set up in the vicinity of the Great Lakes Forest Products Limited, Thunder Bay. The exposed glass-fibre filters were later analyzed for total suspended particulate matter and iron content. Two samplers with Delbag-microsorban filters were also set up and analyzed for sulphate, nitrate, silicon and iron mass loadings.

Based on a 24-hour sampling period, 20 of the 109 exposed glass-fibre filters were found to have total suspended particulate loadings in excess of the ambient air quality Criterion of 120 ug/m^3 . The maximum concentration was 296 ug/m^3 and was exposed at the Dow Chemical site on August 9th. The overall average loading was 72 ug/m^3 with an associated standard deviation of 57 ug/m^3 .

Approximately 4% of the total suspended particulate loading was composed of iron. The average loading of iron was 3.2 ug/m^3 with a standard deviation of 3.1 ug/m^3 . The average concentration of silicon was found to be 17.6 ug/m^3 with a standard deviation of 19.1 ug/m^3 . Results from the analysis of sulphates showed an overall average concentration and standard deviation of 6.2 ug/m^3 and 5.5 ug/m^3 respectively. For nitrates, the respective figures were 0.8 ug/m^3 and 3.9 ug/m^3 . The Delbag-microsorban filters were also analyzed for iron content. The average concentration was 4.1 ug/m^3 with a standard deviation of 4.2 ug/m^3 .

A more complete sulphur analysis was performed using a Tracor #270 HA unit. The samples collected were examined for hydrogen sulphide, methyl mercaptan and ethyl mercaptan. A few qualitative measurements were also undertaken for carbon disulphide, and sulphur dioxide.

From the 44 samples analyzed for this ambient air survey, the overall averages and relative concentrations were: hydrogen sulphide - 17.1 ppb (45%), methyl mercaptan - 11.1 ppb (29%), and ethyl mercaptan - 10.0 ppb (26%). The contribution of the mercaptans to the total reduced sulphur concentrations was therefore approximately 55%. (ppb-parts per billion)

02. Introduction

As requested by the Northwest Region, the Monitoring and Instrumentation Development Unit of the Air Resources Branch conducted an ambient air survey in the areas of Thunder Bay, Red Rock, Marathon and Terrace Bay during the period of July 31 to September 13, 1978.

The sources under investigation in these areas were, respectively, Great Lakes Forest Products Limited (formerly Great Lakes Paper Company Limited); Domtar Packaging Limited; American Can Canada Inc. (formerly American Can of Canada Limited); and Kimberly-Clark of Canada Limited. Total reduced sulphur (expressed as hydrogen sulphide) and sulphur dioxide were the suspected major pollutants originating from these kraft and sulphite pulp mills.

In particular, total hydrocarbons, carbon monoxide, oxides of nitrogen, sulphur dioxide, hydrogen sulphide, methane and ozone in ambient air were monitored. Since the analyzer for hydrogen sulphide was also sensitive to mercaptans and other malodourous sulphur compounds, a more complete sulphur analysis was performed using a Tracor instrument. In addition, the Northwest Region requested information regarding concentrations of airborne total suspended particulate matter in the Thunder Bay area. A Hi-Volume sampler network was set up to perform this task.

03. Source Description

The Great Lakes Forest Products Limited plant is located in the southwest sector of the city of Thunder Bay, Ontario. The plant area is situated near the junction of Highways #11/17 and #61 and lies on the north bank of the Kaministiquia River, 10 km upstream of the Thunder Bay Harbour.

The plant includes a kraft pulp mill, a sulphite pulp mill, a waferboard mill, a stud mill and a significant boiler plant operation.

All monitoring sites were referenced to the main steam plant stack located in the boiler house area at the extreme southeast side of the mill complex. (Refer to Map #1, page 9; UTM co-ordinates X 2920-Y5730).

There exist two geological features that severely affect the wind dynamics in this area. These are the Kaministiquia River Valley and a large promontory (Mt. McKay) which is part of a group of hills (the Norwesters) oriented along a southwest/northeast direction. These features cause channelling of the wind along the west/east direction.

Red Rock (UTM co-ordinates X0850-Y2130) is located on the north shore of Lake Superior, approximately 100 km northeast of Thunder Bay. Adjacent to and due east of Red Rock is the Domtar kraft pulp mill, situated on the northwest bank of Nipigon Bay. A large promontory, Red Rock Hill, orientated along a WNW/ESE direction lies immediately due south of this community and affects the wind dynamics of this area through orographic lift.

All monitoring sites were referenced to the Domtar kraft pulp mill's recovery stacks, located at the extreme southeast end of the mill (UTM co-ordinates X0860-Y 2110; refer to Map #2, page 10).

Marathon is located on the north shore of Lake Superior, approximately 200

km east of Thunder Bay. Immediately to the west of Marathon is a kraft pulp mill owned by American Can Canada Inc. This mill lies in a sheltered cove (Jellicoe) and is situated on the northeast side of a large promontory called Peninsula Hill. All monitoring sites were referenced to the main stacks of the pulp mill (UTM co-ordinates X4445-Y9610; refer to Map #3, page 11).

The Kimberly-Clark kraft pulp mill is located approximately 2 km north of the town of Terrace Bay, on the north shore of Lake Superior. A man-made effluent ditch, originating from this kraft pulp mill, runs in a northeasterly direction and intersects Highway #17 approximately 4 km northeast of Terrace Bay. This ditch eventually joins a natural water system which intersects Highway #17 twice again before eventually flowing into Lake Superior.

Because of the flat terrain of the area, very little orographic wind modification/interaction was observed in Terrace Bay.

All monitoring sites were referenced to the old power boiler stack located at the southwest side of the Kimberly-Clark mill (UTM-co-ordinates X9220-Y0470). The first crossing of the effluent ditch is located at UTM co-ordinates X9385-Y0660. Refer to Map #4, page 12.

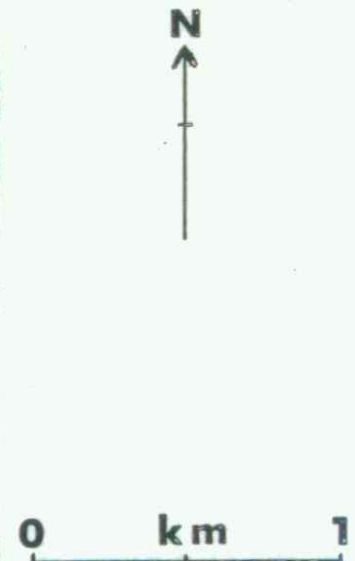
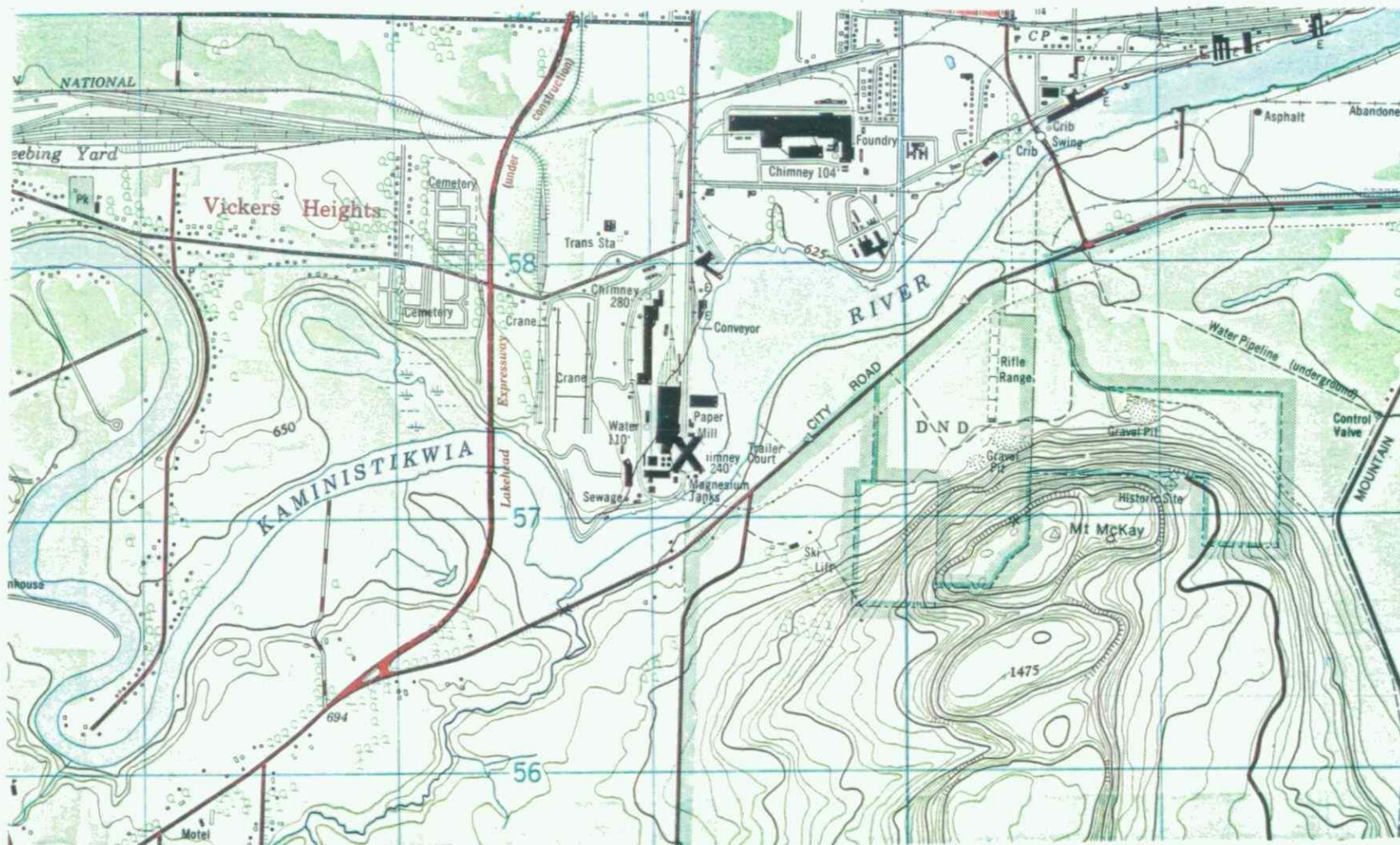
1978 - AMBIENT AIR SURVEY

SOURCE LOCATION

THUNDER BAY

MAIN STEAM PLANT STACK

CO-ORDINATES (X2920-Y5730)



Map #1

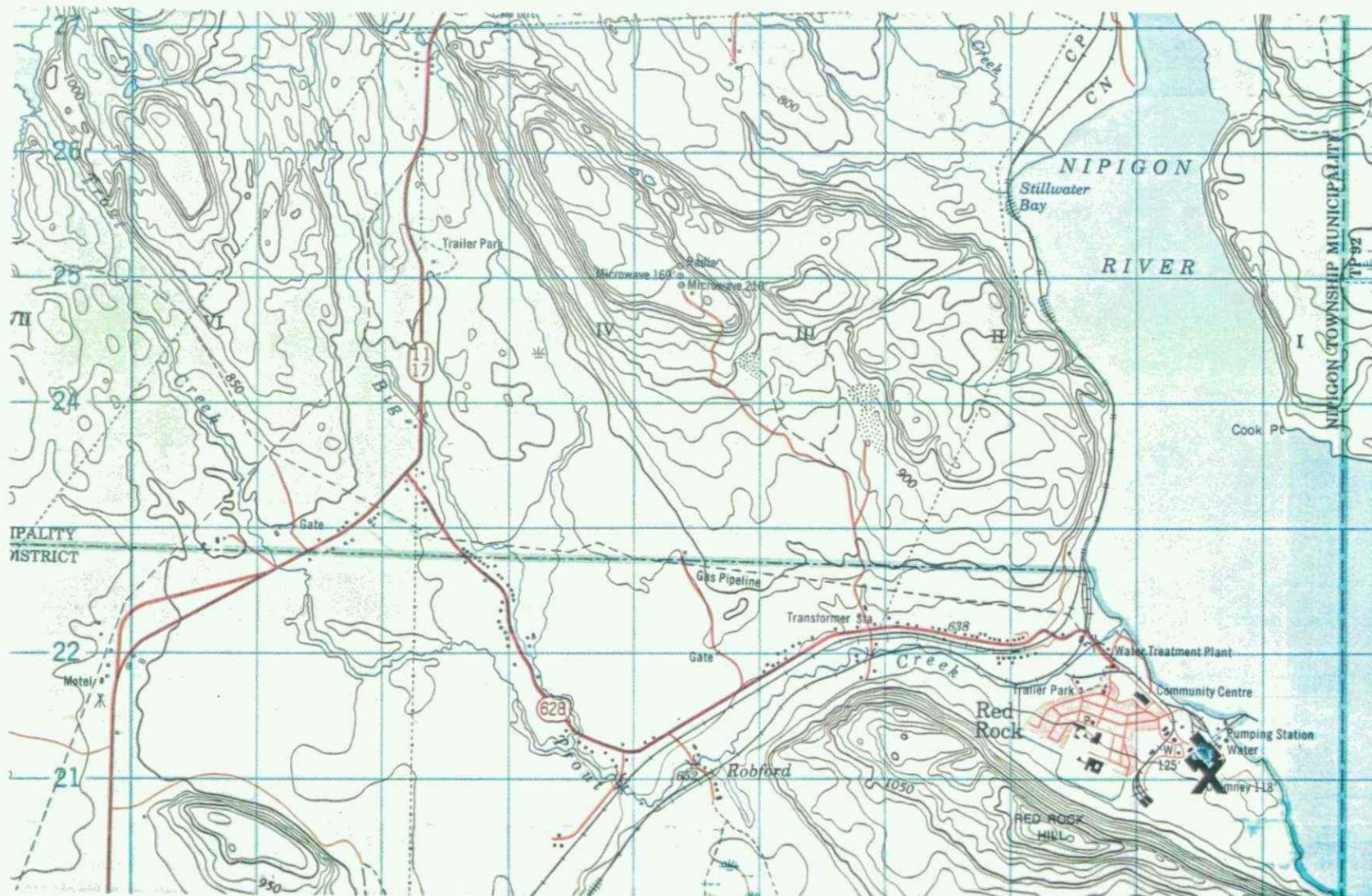
1978 - AMBIENT AIR SURVEY

SOURCE LOCATION

RED ROCK

RECOVERY STACKS

CO-ORDINATES (X0860-Y2110)



0 2 km

Map #2

-10-



1978 - AMBIENT AIR SURVEY

SOURCE LOCATION

MARATHON

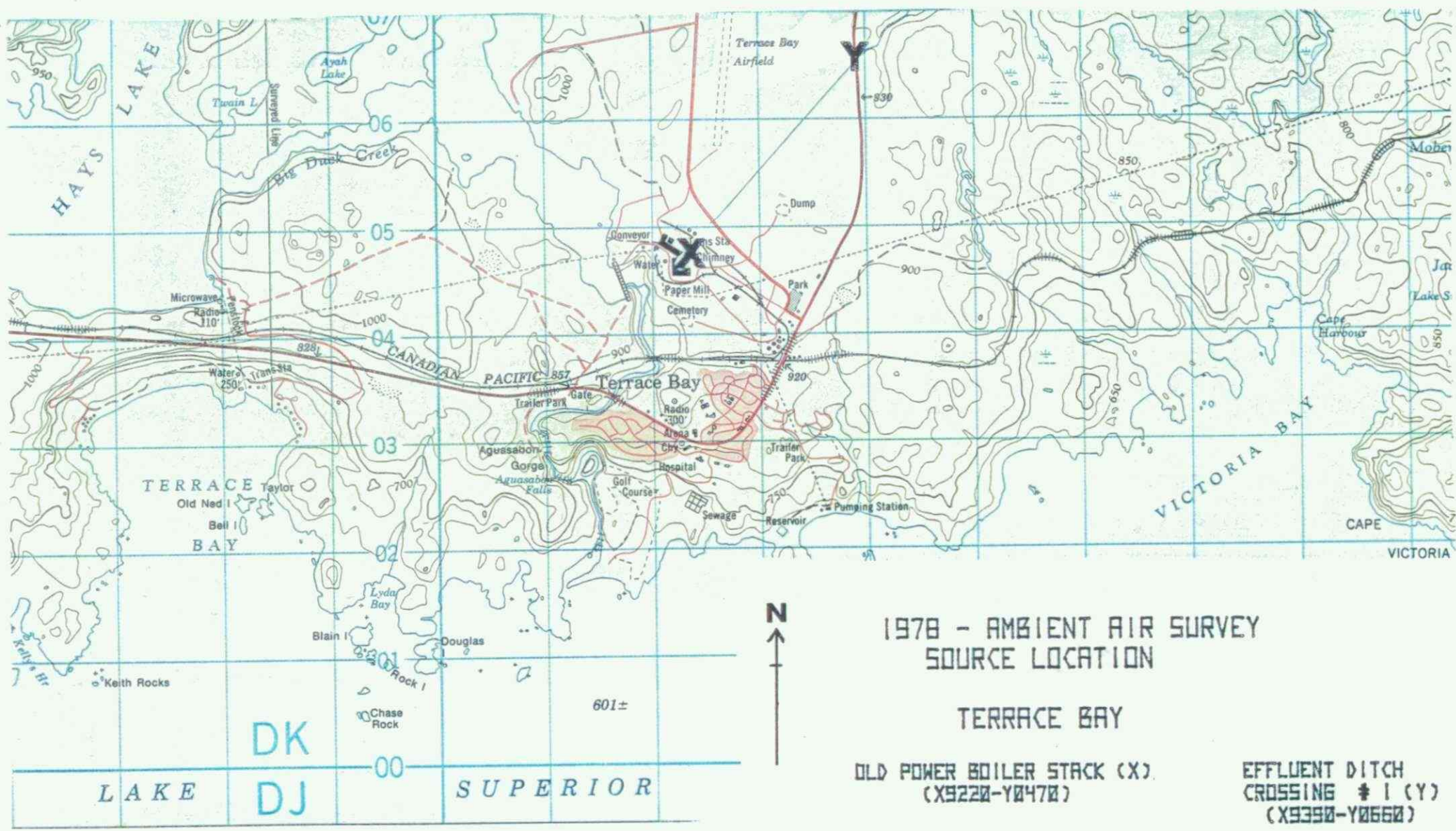
MAIN STACKS
(X4445-Y9610)



0 2 km

Map #3

-11-



1978 - AMBIENT AIR SURVEY
SOURCE LOCATION

TERRACE BAY

OLD POWER BOILER STACK (X)
(X9220-Y0470)

EFFLUENT DITCH
CROSSING #1 (Y)
(X9390-Y0660)

0 2 km

04. Survey Technique

Analytical instrumentation housed in a 1975 General Motors Corporation Transmode was utilized to monitor the air quality in the vicinities of the kraft and sulphite pulp and paper mills located in Thunder Bay, Red Rock, Marathon, and Terrace Bay. This mobile air monitoring (MAM) unit was equipped with an automated data acquisition system (Hewlett & Packard 9830A mini-computer) and on-board electric generators for fully automated, independent and continuous monitoring capabilities. The HP 9830A mini-computer performed initial data analyses in the field (re: accuracy & validity) whereas the final data reduction and analyses were carried out by a larger computer system located within the Air Resources Branch at 880 Bay Street, Toronto.

The MAM unit had permanently installed analyzers for monitoring sulphur dioxide, hydrogen sulphide, carbon monoxide, ozone, oxides of nitrogen, total hydrocarbons, and methane. Meteorological instrumentation for monitoring wind speed, wind direction, relative humidity, temperature, barometric pressure and solar radiation was also included in this instrumentation package. See Table #1 page 15, for listing of the above.

Following an assessment of wind direction and wind speed and other pertinent meteorological conditions and in conjunction with visual and olfactory observations, the approximate locations of maximum impingement zones were found and ambient air monitoring was initiated within these areas. Air quality was continuously monitored for at least 45 minutes at each site.

Five standard Hi-Volume samplers utilizing glass-fibre filters were used for the determination of the mass loadings of total suspended particulate matter (TSP) and iron (Fe). They were located at several distances and directions from the sources investigated.

Two Hi-Volume samplers were also set-up using Delbag-microsorban filters as the collection media. These samples were analyzed for silicon, sulphates, nitrates and iron.

A Tracor #270HA unit was used for a more complete analysis of the reduced sulphur compounds. These samples were analyzed for methyl mercaptan, ethyl mercaptan, hydrogen sulphide, carbon disulphide and sulphur dioxide by this instrument and this programme was run concurrently with the MAM programme during the latter part of this survey.

A Tracor #270HA unit was used for a more complete analysis of the reduced sulphur compounds. These samples were analyzed for methyl mercaptan, ethyl mercaptan, hydrogen sulphide, carbon disulphide and sulphur dioxide by this instrument and this programme was run concurrently with the MAM programme during the latter part of this survey.

Table 1: INSTRUMENTATION - GMC

<u>Instrument</u>	<u>Manufacturer</u>	<u>Analytical Technique</u>	<u>Maximum Sensitivity (Full Scale)</u>
H ₂ S Source	Hartmann & Braun (H&BPrüfgasgenerator)	N/A	N/A
H ₂ S Analyzer	H&B Picos	electrochemical	0.05 ppm
SO ₂ Source	H&B Prüfgasgenerator	N/A	N/A
SO ₂ Analyzer	H&B Picoflux 2	conductometric	0.3 ppm
O ₃ Analyzer/Source	Bendix 8002	chemiluminescent	0.05 ppm
NO _x , NO ₂ , NO Analyzer	Bendix 8101-B	chemiluminescent	0.5 ppm
CO Analyzer	H&B Uras 2T	Infrared Absorption	50 ppm
THC, CH ₄ , THC-CH ₄ Analyzer	Ingenieur - Produktions-Gruppe München (IPM) RS-5	Dual flame ionization detector	50 ppm THC (as CH ₄)
Hg Analyzer	Scintrex HGP-2	Ultra-violet Absorption	200 ng/m ³
CO, THC, THC-CH ₄ , CH ₄ source	Matheson	compressed gas	N/A

<u>Instrument</u>	<u>Manufacturer</u>	<u>Scale</u>
**Wind speed	Lambrecht gmBH	km/hr
**Wind Direction	Lambrecht gmBH	degrees
Temperature	Weather Measure (WM) T621	°C
Relative humidity	WM-HM-IIIIP	percent
Barometric pressure	WM-BM70-B242	millibars
Solar radiation	WM Star Pyranometer	watts/cm ²

** These wind indicators are located on top of a 10-metre retractable mast.

05. Monitoring Technique

Sample Collection

The ambient air sample was taken at a constant flow rate (approximately 0.2 cubic meters/min) by a probe located on top of the MAM unit, and whose inlet was approximately 5 meters above ground level. The air sample entered a manifold from which each analyzer was parallel tapped with a minimal length of teflon sampling line. This arrangement ensured little or no sample degradation, minimal delay time and minimal sample contamination due to ground level sources (eg. entrained soil, vehicular exhaust, etc.).

Instrumentation - analyzers

The instrumentation associated with the GMC Transmode unit is presented in Table #1, page 15.

Sulphur Analysis - Tracor

A Tracor #270HA unit, equipped with a flame photometric detector, was used to analyze the sulphur compound concentrations. Quantification of the individual sulphur compounds as monitored by the H_2S analyzer was carried out by this instrument. The flame photometric detector is sensitive to the total reduced sulphur compounds such as hydrogen sulphide (H_2S), methyl mercaptan (CH_3SH or MeSH) and ethyl mercaptan (EtSH). It should be reiterated that the H_2S analyzer cannot make the distinction between the aforementioned sulphur compounds and is sensitive to the HS^- group in general, thus the response of the H_2S analyzer will be noted as Total Reduced Sulphur (TRS). The air samples were gathered in polyester, multi-layer mylar bags, downwind of the major pulp and paper mills under investigation during this survey.

The detection limit for MeSH was approximately 5 to 10 ppb (parts per

billion). Reported concentrations in this range may be subject to a 50-100% error, depending on the base-line noise level. However, concentrations in excess of 10 ppb will have a 20% error, with accuracy increasing with concentration.

The quantitative accuracy of ethyl mercaptan is the same as methyl mercaptan. (See attached calibration curves, Graphs #1 and #2 on pages 78 and 79).

The reported concentrations for hydrogen sulphide may also include carbonyl sulphide (COS), as the analytical method does not distinguish between these two compounds. The detection limit for H_2S was found to be approximately 1 ppb with a 50 to 100% accuracy up to 5 ppb. Above 5 ppb, the accuracy improved proportionally.

It should also be mentioned that the ethyl mercaptan concentration figures may also include some dimethyl sulphide ($(CH_3)_2S$).

For additional information, a few measurements were undertaken for carbon disulphide (CS_2) and sulphur dioxide (SO_2); however, measurements for SO_2 were only qualitative since the analyzer was not calibrated for this compound. (For the CS_2 calibration curve, see Graph #3, page 80.)

Table #12 on pages 122 to 123, lists the site locations at which ambient air samples were gathered for Tracor analyses.

Table #14 on pages 125 to 126, lists the raw data and the statistical summary is presented in Table #13 on page 124.

With respect to the statistical summary table, a "trace" was assigned a concentration of $\frac{1}{2}$ the lowest detection level for that particular contaminant.

Meteorological Analysis

Meteorological conditions were monitored on a continuous basis by the

instrumentation associated with the MAM unit (refer to Table #1 on page 15).

Additional information regarding air mass movements and daily weather statistics was provided by the Atmospheric Environment Service.

Calibration

Analyzers and sources were calibrated before the survey. During the survey, the analyzers' calibration was checked at least once every day using the sources and built-in electronic circuitry. All monitors were found to be extremely stable and the calibration remained within the prescribed limits throughout the duration of the survey. Immediately following the completion of this survey, all instruments were rechecked in the laboratory and all calibration statistics were found to be satisfactory.

For the hydrogen sulphide analyzer, after a calibration span had been performed, a minimum of 30 minutes was generally given before monitoring began to allow the residual span gas to be flushed out of the system and to allow the analyzer to stabilize. If not enough time was given, an exponential decay of the hydrogen sulphide concentrations would be present in the initial part of the data.

06 Monitoring Site Locations

Ambient air monitoring sites for Thunder Bay, Red Rock, Marathon and Terrace Bay are shown on Maps #5 to 8, pages 20, 25, 26 and 28 respectively. Tables #2 to 5, pages 21-24, 27 and 30 contain complete site descriptions for these locations.

Hi-Volume sampler monitoring sites are shown on Map #9, page 29 and Table #6, page 30 contains the site descriptions for these stations.

The reference point in UTM co-ordinates used for each pulp mill is listed below:

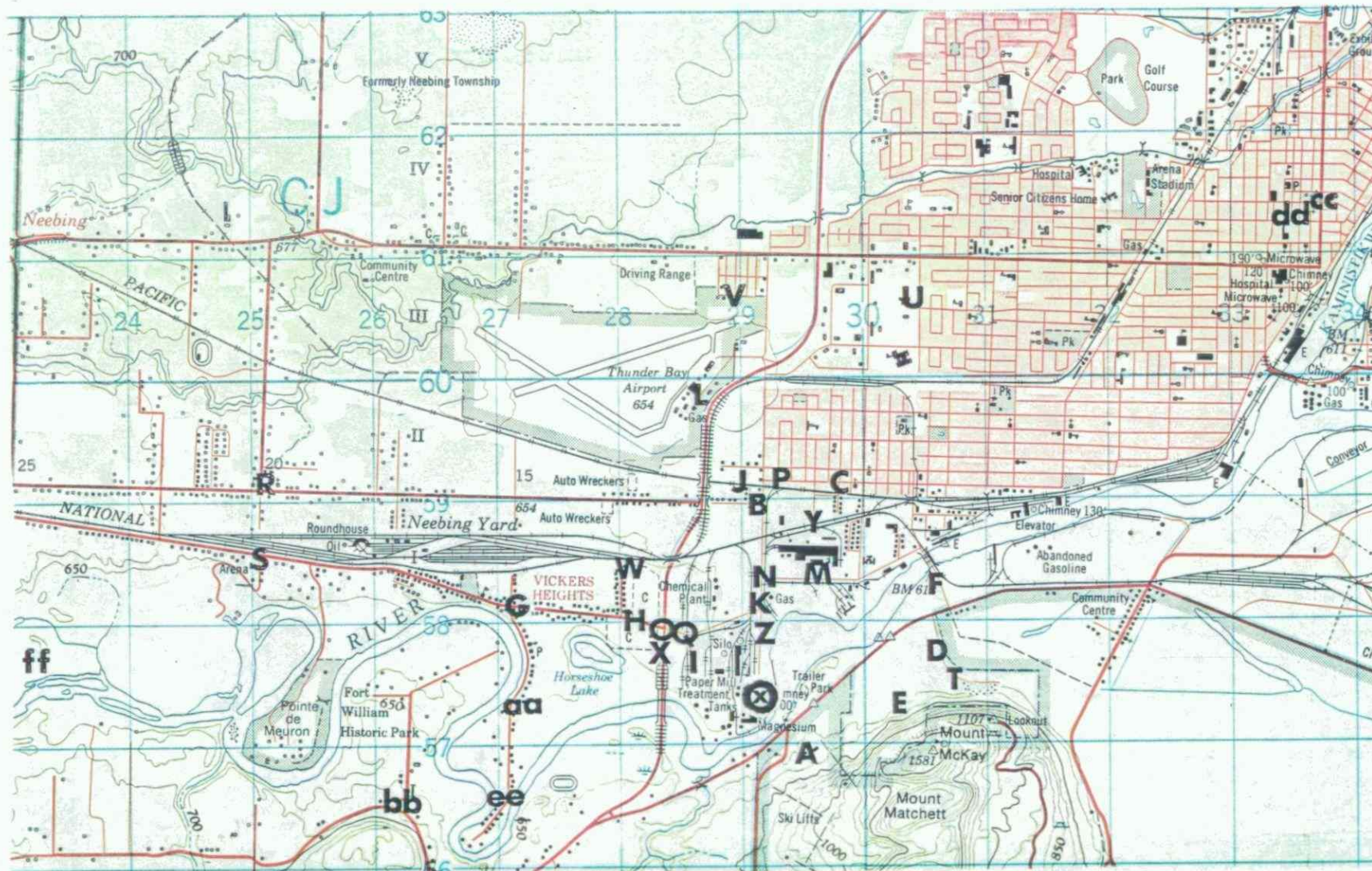
<u>Area</u>	<u>Reference Point</u>	
Thunder Bay	X2920 - Y5730	where X = 3 and Y = 53
Red Rock	X0860 - Y2110	where X = 4 and Y = 54
Marathon	X4445 - Y9610	where X = 5 and Y = 53
Terrace Bay	X9220 - Y0470	where X = 4 and Y = 54

accuracy = \pm 50 metres

GREAT LAKES FOREST PRODUCTS LIMITED

THUNDER BAY, ONTARIO

MONITORING SITES



Reference
Point -



Map #5

-20-

Scale - km



TABLE #2
MOBILE AIR MONITORING SITES

THUNDER BAY #X

Site (x)	Map ID	Location & UTM Coordinates	Distance (KM)	Bearing (DEG)	Date (1978)
1	A	Mt. McKay Ski Hill (X2950-Y5690)	0.6	140	July 31
2	B	Neebing Ave. & Rosslyn Rd. (X2915 - Y5895)	1.5	000	Aug. 1
3	C	Gore St. & Crawford Ave. (X2980-Y5915)	1.9	020	Aug. 1
4	D	Gravel Pit Rd. (X3060-Y5770)	1.5	080	Aug. 2
5	D	Gravel Pit Rd. (X3060-Y5770)	1.5	080	Aug. 2
6	D	Gravel Pit Rd. (X3060-Y5770)	1.5	080	Aug. 3
7	E	D.N.D. Rifle Range (X3035-Y5730)	1.1	090	Aug. 3
8	F	C.N.R.A. Rec. Centre (X3050-Y5830)	1.7	050	Aug. 3
9	F	C.N.R.A. Rec. Centre (X3050-Y5830)	1.7	050	Aug. 4
10	E	D.N.D. Rifle Range (X3035-Y5730)	1.1	090	Aug. 5
11	G	Broadway Ave. & Victor Ave. (X2710-Y5810)	2.2	290	Aug. 5
12	H	Vickers Hts. Cemetery (X2810-Y5800)	1.2	300	Aug. 6
14	I	GLFP Plant Rd. (X2860-Y5760)	0.6	290	Aug. 6
15	J	Dow Gate (X2900-Y5910)	1.8	355	Aug. 7
16	K	GLFP Plant Sign (X2910-Y5810)	0.8	000	Aug. 7
NB	GLFP - Great Lakes Forest Products				

TABLE #2 (cont'd)

Site (x)	Map ID	Location & UTM Coordinates	Distance (KM)	Bearing (DEG)	Date (1978)
17	L	Road at Air Met. Office (X2875-Y5980)	2.5	345	Aug. 10
18	K	GLFP Plant Sign (X2910-Y5810)	0.8	000	Aug. 10
19	M	Can-Car (X2960-Y5840)	1.1	025	Aug. 10
20	N	Neebing & Montreal Sts. (X2920-Y5830)	1.0	005	Aug. 11
21	F	C.N.R.A. Rec. Centre (X3050-Y5830)	1.7	050	Aug. 11
22	M	Can-Car (X2960-Y5840)	1.1	025	Aug. 12
23	M	Can-Car (X2960-Y5840)	1.1	025	Aug. 12
24	O	HWY #61 & Broadway (X2840-Y5800)	1.0	305	Aug. 13
25	O	HWY #61 & Broadway (X2840 - Y5800)	1.0	305	Aug. 13
26	N	Neebing & Montreal Sts. (X2920-Y5830)	1.0	005	Aug. 14
27	P	Gore St., 0.1 km E of Neebing Ave. (X2925-Y5910)	1.7	005	Aug. 14
28	N	Neebing & Montreal Sts. (X2920-Y5830)	1.0	005	Aug. 14
30	Q	HWY #61 & Broadway (X2850-Y5795)	0.8	305	Aug. 17
31	R	Rosslyn Rd. & 20th Side Rd. (X2505-Y5910)	4.4	290	Aug. 17
32	S	Broadway & Bowlker (X2505-Y5850)	4.2	285	Aug. 17
33	T	Gravel Pit Rd. (X3070-Y5760)	1.6	080	Aug. 18
34	E	D.N.D. Rifle Range (X3035-Y5730)	1.1	090	Aug. 19

TABLE #2 (cont'd)

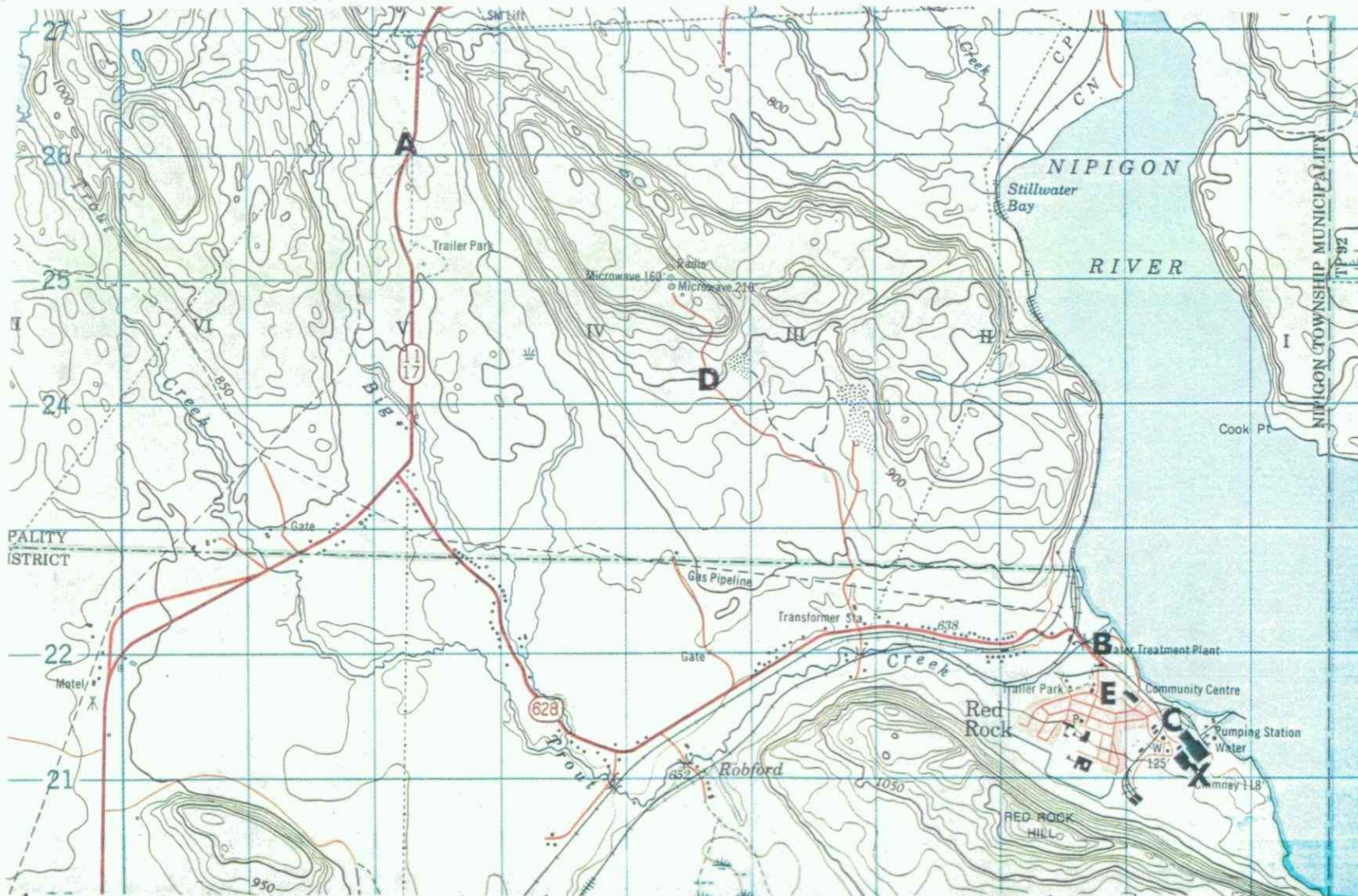
Site (x)	MAP ID	Location & UTM Coordinates	Distance (KM)	Bearing (DEG)	Date 1978
35	E	D.N.D. Rifle Range (X3035-Y5730)	1.1	090	Aug. 19
37	U	M.O.E. Lab (X3040-Y6070)	3.5	020	Aug. 20
38	V	End of Airport Runway (X2890-Y6070)	3.3	355	Aug. 21
39	N	Montreal & Neebing Sts. (X2920-Y5830)	1.0	005	Aug. 21
40	N	Montreal & Neebing Sts. (X2920-Y5830)	1.0	005	Aug. 21
41	A	Mt. McKay Ski Hill (X2950-Y5690)	0.6	140	Aug. 22
42	W	Meryle Ave. at RR tracks (X2810-Y5850)	1.5	315	Aug. 22
43	aa	Victor Ave., 1km S of Broadway (X2710-Y5720)	2.0	265	Aug. 23
44	bb	Riverdale Rd. (X2620-Y5650)	3.0	250	Aug. 23
45	cc	Miles & May Sts. (X3375-Y6140)	6.1	045	Aug. 24
46	dd	McKellar & Victoria Sts. (X3345 - X6130)	5.8	045	Aug. 24
48	U	M.O.E. Lab (X3040-Y6070)	3.5	020	Aug. 24
50	N	Neebing & Montreal Sts. (X2920-Y5830)	1.0	005	Aug. 25
52	U	M.O.E. Lab (X3040-Y6070)	3.5	020	Sept. 2
53	N	Montreal & Neebing Sts. (X2920-Y5830)	1.0	005	Sept. 3
54	J	Broadway Ave. (X2900-Y5800)	0.6	345	Sept. 4
55	U	M.O.E. Lab (X3040-Y6070)	3.5	020	Sept. 4

TABLE #2 (cont'd)

Site (x)	Map ID	Location & UTM Coordinates	Distance (KM)	Bearing (DEG)	Date (1978)
56	X	HWY #61, 0.2 km S of Broadway (X2830-Y5780)	0.9	295	Sept. 5
57	W	N end of Meryle Ave, Vicker's Hts. (X2810-Y5850)	1.5	315	Sept. 5
58	Y	Stanley St., N. of Can-Car (X2960-Y5880)	1.5	015	Sept. 6
59	N	Montreal & Neebing Sts. (X2920-Y5830)	1.0	005	Sept. 6
60	Z	GLFP Park. Lot, Concrete Footings (X2920-Y5790)	0.5	005	Sept. 6
61	X	HWY #61, 0.3 km S of Broadway (X2830-Y5770)	0.9	290	Sept. 6
62	X	HWY #61, 0.2 km S of Broadway (X2830-Y5780)	0.9	295	Sept. 6
63	ee	Victor St., Vicker's Hts. (X2700-Y5650)	2.3	245	Sept. 6
64	X	HWY #61, 0.2 km S of Broadway (X2830-Y5780)	0.9	295	Sept. 7
65	ff	Side Rd. N. of Riverdale Rd. (X2320-Y5780)	5.9	270	Sept. 7
66	H	Broadway, Cemetery Gates (X2820-Y5800)	1.1	305	Sept. 7
67	O	HWY #61, 0.1 km S. of Broadway (X2830-Y5790)	1.0	290	Sept. 8
68	O	HWY #61 & Broadway (X2830-Y5800)	1.0	305	Sept. 8
69	O	HWY #61 & Broadway (X2830-Y5800)	1.0	305	Sept. 8
70	O	HWY #61 & Broadway, Cemetery (X2820-Y5800)	1.1	305	Sept. 9
71	X	HWY #61, 0.2 km S of Broadway (X2830-Y5780)	0.9	295	Sept. 9
72	O	HWY #61 & Broadway, Cemetery (X2830-Y5800)	1.0	305	Sept. 9

DOMTAR PACKAGING LTD.
RED ROCK, ONTARIO

MONITORING SITES



Reference
Point - X

Map #6
-25-



Scale

0 2 km

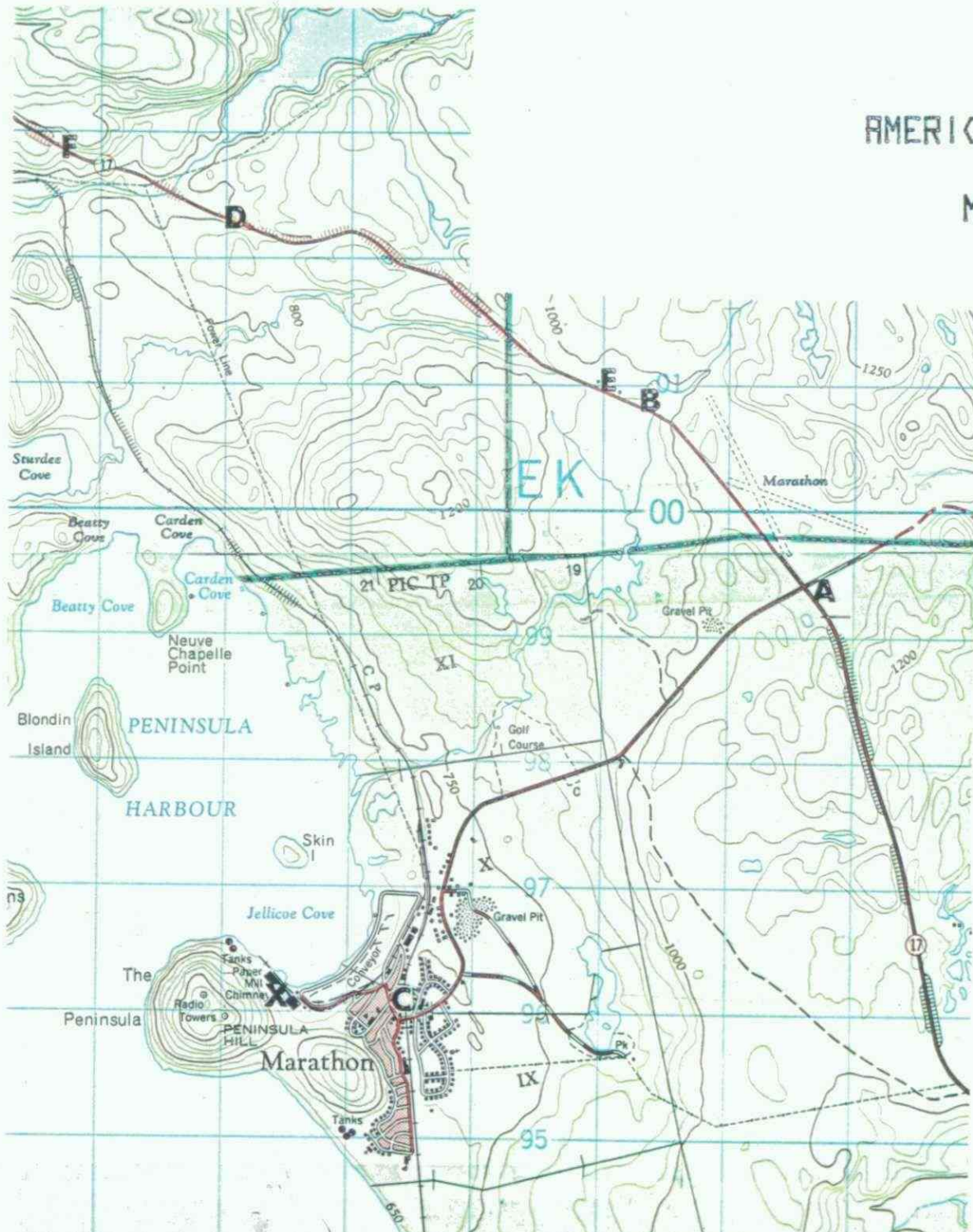


TABLE #3

Mobile Air Monitoring Sites

RED ROCK #X

Site (x)	Map ID	Location & UTM Coordinates	Distance (KM)	Bearing (DEG)	Date (1978)
1	A	HWY #17, 1.6 km W of Golf Club Rd. (X0230-Y2605)	8	310	Aug. 26
2	B	Water Treatment Plant, NW of Mill (X0780-Y2205)	1.3	320	Aug. 26
3	C	0.1 km E of fence, 0.1 km SE of Esso (X0835-Y2150)	0.5	340	Aug. 27
4	D	2.4 km N of HWY #628 on Red Rock Rd. #1 (X0560-Y2415)	5	310	Aug. 27
5	E	Red Rock Inn (X0785-Y2165)	1.0	310	Aug. 27

TABLE #4

Mobile Air Monitoring Sites

MARATHON #X

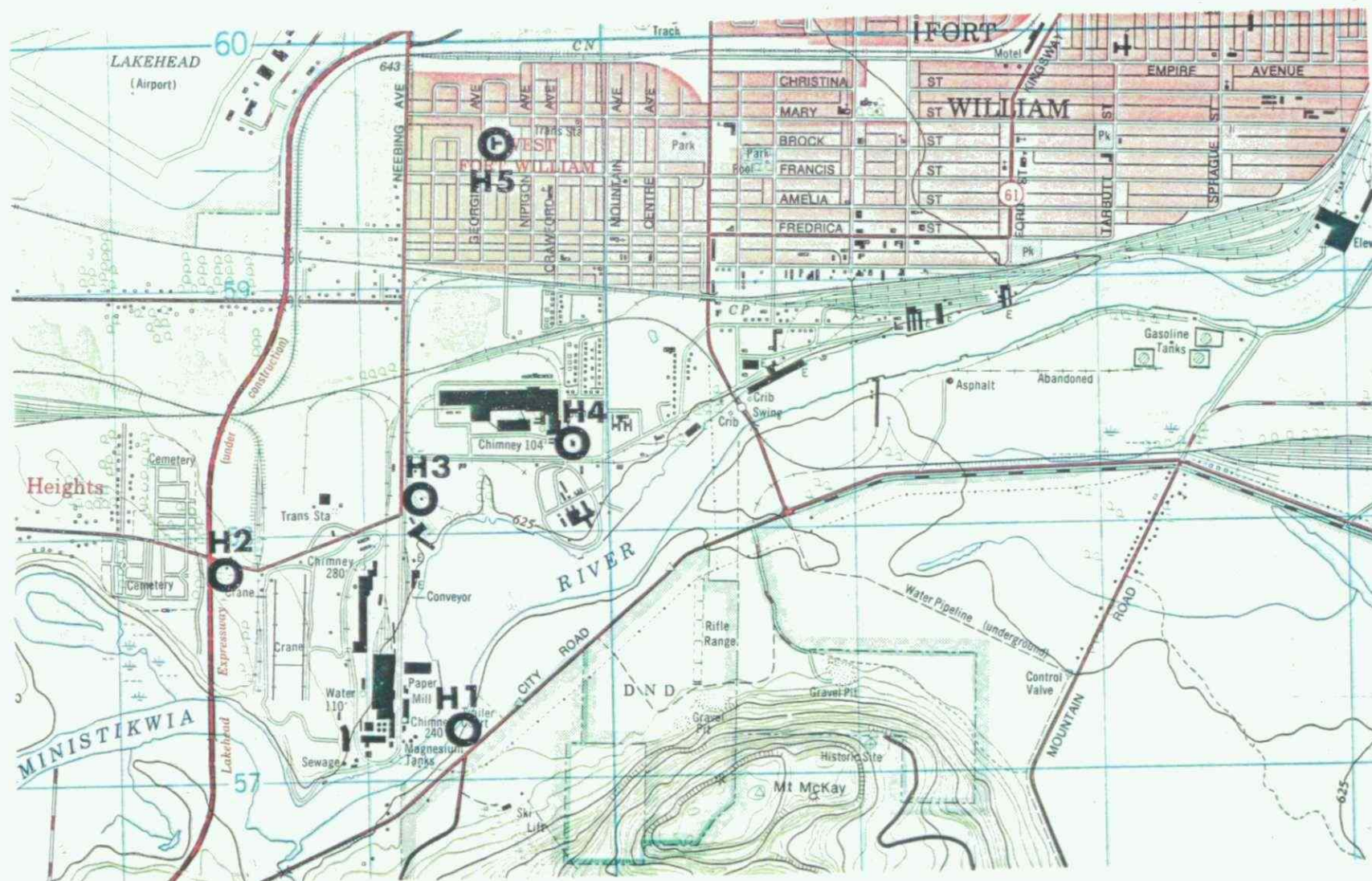
Site (x)	Map ID	Location & UTM Coordinates	Distance (km)	Bearing (DEG)	Date (1978)
1	A	Tourist Booth on HWY #17 (X4875-Y9940)	5.9	045	Aug. 29
2	B	Ministry of Trans. & Comm. on HWY #17 (X4740-Y0085)	5.6	030	Aug. 29
4	C	Water Tower in Downtown Marathon (X4545-Y9615)	1.0	090	Aug. 29
5	D	3.2 km W of OPP Station on HWY #17 (X4410-Y0230)	6.2	355	Aug. 31
6	E	OPP Station on HWY #17 (X4700-Y0100)	5.5	025	Aug. 31
7	F	0.8 km W of Angler's Creek on Hwy #17 (X4275-Y0285)	7	345	Aug. 31

KIMBERLY-CLARK OF CANADA LIMITED
TERRACE BAY, ONTARIO
MONITORING SITES



GREAT LAKES FOREST PRODUCTS LIMITED THUNDER BAY, ONTARIO

HI-VOL SITES



Map #9

TABLE #5

Mobile Air Monitoring Sites

TERRACE BAY #X

Site (x)	Map ID	Location & UTM Coordinates	Distance (km)	Bearing (DEG)	Date (1978)
1	A	Moose Lodge, Off Mill Rd. (X9300-Y0400)	1.1	130	Aug. 28
2	B	First Effluent Crossing (X9390-Y0660)	2.5	050	Aug. 30
3	C	Adjacent to Clarifier & Settling Pond (X9255-Y0510)	1.1	050	Sept. 1

TABLE #6

Hi-Volume Samplers - Site Description

THUNDER BAY

Site #	Type of Filter Used	Location & Description	Distance & Direction from Source
H1	Glass-fibre	Trailer Court on Hwy #61B (X2950-Y5730)	0.3 km & 120 degrees
H2	Glass-fibre	Hwy #61 & Broadway (Mr. M. Tocheri's Property) (2840-Y5790)	0.9 km & 305 degrees
H3	Glass-fibre & Delbag-microsorban	Dow Chemical Storage Area (2035-Y5840)	0.8 km & 005 degrees
H4	Glass-fibre & Delbag-microsorban	Can-Car, Roof of Office Bldg. (X2980-Y5840)	1.2 km & 030 degrees
H5	Glass-fibre	St. Anne's School (X2955-Y5956)	2.2 km & 010 degrees

07 Results

Definition of Terms-

Scan Time: Frequency of interrogation of the monitoring instrumentation by the data acquisition system.

Time: Time of the first & final scans used to determine running averages.

Number of Readings: Number of scans

MAM: Mobile Air Monitoring

glc: Ground level concentrations

MP: Monitoring period

All statistical values are based on cumulative averages of continuous instantaneous interrogations of the analytical instruments and all results are expressed in parts per million (ppm). Due to the voluminous nature of the processed data, an addendum entitled, "Ambient Air Survey in the Areas of Thunder Bay, Red Rock, Marathon and Terrace Bay. - 1978; Compilation of Time Averaged Data", will accompany this report and will be presented upon request. Both 30 and 60 minute averages will be presented in this addendum.

The statistical summary of the collected data is presented in Tables #7 to 14, pages 81 to 126. Supplementing these tables, concentration versus time graphs are presented in Figures #1 to #15, pages 50 to 64. In order to determine the origins of the pollutants, wind rose/concentration analyses were performed (see Maps #10 to #15, pages 72 to 77) as well as correlation plots (Figures #16 to #22, pages 65 to 71).

Results from the Hi-Volume analysis are presented in Table #11, pages 113 to 121. The Tracor sampling statistics and the statistical summary of the sulphur analysis are presented in Tables #12 and #13, pages 122 to 124. The raw data collected for this sulphur analysis is presented in Table #14, pages 125 and 126.

08 Discussion

This northwest ambient air survey was carried out between July 31 and September 13, 1978. The areas of interest were at Thunder Bay, Red Rock, Marathon and Terrace Bay; all major centres along the northwest coast of Lake Superior. Prior to this period, the weather in Ontario was very dry (June and July) with near drought conditions. August weather had mainly sunny days, cool nights (many nocturnal inversions) and abundant rainfall to alleviate the near drought conditions. September was similar to August. During this survey period, approximately 8 major frontal systems pushed through the Great Lakes area. Regarding incumbent weather, two quasistationary frontal systems prevailed between August 13 to 17 and September 5 to 12.

Since this ambient air survey dealt mainly with monitoring in the vicinity of pulp and paper mills, sulphur dioxide (SO_2) and total reduced sulphur (TRS-reported as hydrogen sulphide, H_2S) could, in general, be attributable to single, discrete sources. Therefore the 30-minute average ground level concentration (glc) values of these contaminants were investigated and compared to their respective Standards as set out in Schedule 1, Regulation 15 of the Ontario Environmental Protection Act. Nitrogen dioxide (NO_2) and ozone (O_3) were two other contaminants of interest during this survey; however, the glc's for these contaminants were found to be, in general low, and hence long range mass transport and/or multi-source contribution were assumed to be the major contributors. For these reasons, one-hour average glc's of NO_2 and O_3 were examined and compared to their respective desirable ambient air quality Criteria as set out in the Ontario Regulation 872/74, S.1 of the 1971 Environmental Protection Act.

Therefore the following table lists these contaminants and their respective Ontario ambient air quality Guideline, Standard or Criterion.

<u>Contaminant</u>	<u>Maximum Acceptable Concentration*</u>	<u>Average Time</u>	<u>Classification</u>
Sulphur Dioxide (SO ₂)	0.30 ppm	30 min	Standard
Oxides of Nitrogen (NO _x)**	0.27 ppm	30 min	Standard
Total Reduced Sulphur (TRS, H ₂ S)***	0.027 ppm	30 min	Guideline
Nitrogen Dioxide(NO ₂)****	0.20 ppm	60 min	Criterion
Ozone (O ₃)	0.08 ppm	60 min	Criterion
Total Suspended Particulate (TSP)	120 ug/m ³	24 hour	Criterion

* Conversion from ug/m³ to ppm was made under the following conditions;
Temperature: 298°K (25°C), atmospheric pressure: 101.6 kPa

** Expressed as concentrations of nitrogen dioxide

*** The H₂S analyzers were also sensitive to mercaptans and other malodorous sulphur compounds containing the HS⁻ group. Thus, the results are reported as total reduced sulphur (TRS) and expressed as concentrations of hydrogen sulphide.

**** Nitric oxide (NO) in the presence of ozone (O₃) readily forms nitrogen dioxide (NO₂). Long time integrated samples (usually 24 hours), when analyzed, contain little or no NO because of this conversion feature. Our analyzer distinguishes between NO and NO₂ and collectively denotes them as oxides of nitrogen (NO_x).

Additional compounds were monitored by the instrumentation associated with the MAM unit. These included carbon monoxide and total hydrocarbons. However, they will not be discussed in this report but rather presented as a data base for future studies.

A High-Volume sampler network was set up in the vicinity of the Great Lakes Forest Products Company in Thunder Bay in order to investigate the ambient air

mass loadings of total suspended particulate (TSP) and iron (Fe). This programme was run concurrently with the MAM programme.

The components of TRS; i.e. - methyl mercaptan, ethyl mercaptan, and hydrogen sulphide were investigated by a Tracor #270HA sulphur analyzer. In addition, a small number of samples were analyzed for carbon disulphide and sulphur dioxide of which the Tracor unit was calibrated for the former. Since the analyzer was not calibrated for sulphur dioxide, the reported concentrations of this compound are qualitative. This analyzer was run in conjunction with the MAM sampling programme towards the latter end of this survey. The main purpose of this analyzer was to determine the percentage contribution of the above sulphur compounds to the net TRS mass loading.

For this entire survey, over 584 hours of accumulated ground level concentration data for the aforementioned contaminants were collected at the various monitoring sites. For clarity, the discussion will proceed as follows:

- (i) Thunder Bay - TRS, SO_2 , O_3 , NO_x , Hi-Volume Analysis, Tracor Analysis
- (ii) Red Rock - TRS, SO_2 , O_3 , NO_x , Tracor Analysis
- (iii) Marathon - TRS, SO_2 , O_3 , NO_x , Tracor Analysis
- (iv) Terrace Bay - TRS, SO_2 , O_3 , NO_x , Tracor Analysis

The survey periods for the MAM unit were:

Thunder Bay	July 31 - Aug. 25; Sept. 2 - Sept. 9.
Red Rock	Aug. 26, 27
Marathon	Aug. 29 - Sept. 1
Terrace Bay	Aug. 28 - Sept. 1

(i) Thunder Bay

Over 468 hours of glc data were collected by the MAM unit on each of the aforementioned contaminants in the vicinity of Great Lakes Forest Products Limited.

Total Reduced Sulphur - TRS (expressed as H_2S)

As noted in the statistical summary tables (Tables #7a, pages 81 to 85), the Guideline for TRS (0.027 ppm) was attained or exceeded during 7 of the 66 monitoring periods comprising this portion of the NW survey for an aggregate time of 8½ hours (approximately 2% of the total monitoring time). The overall average glc of TRS for this entire survey period was 0.007 ppm with an associated standard deviation 0.011 ppm.

The maximum 30-minute average TRS glc was 0.07 ppm and was recorded during monitoring period (MP) Thunder Bay #16 on August 7 (see Figure #1, page 50). The MAM unit was located approximately 0.7 km directly north of the source. The winds were brisk (10 to 15 km/hr) and southerly and therefore the MAM unit was found to be in the impingement zone from the main steam plant stack as referenced in Map #5, on page 20. On this same day, TRS data acquired outside this impingement zone (see statistical results of MP Thunder Bay #14, Table #7a, page 50) denoted 30-minute average glc's of approximately 0.001 ppm. The wind/concentration rose analysis for MP Thunder Bay #16 clearly points to Great Lakes Forest Products Limited as being the major source of TRS. (see Map #10 on page 72).

Sulphur Dioxide - SO_2

Low glc's of SO_2 were detected in the vicinity of Great Lakes Forest Products during this survey. The overall average glc of SO_2 and respective standard deviation was 0.006 ppm and 0.005 ppm. For the 451 hours SO_2 glc's were monitored, the SO_2 30-minute Standard (0.30 ppm) was never exceeded.

The maximum instantaneous and 30-minute average SO_2 glc was 0.333 ppm and 0.140 ppm respectively. This elevated concentration was acquired during MP Thunder Bay #53 on September 3rd. Due to the time of these peak occurrences in the concentration/time graph (Figure #2 on page 51) and the observations of the field operators, these concentrations may be directly attributable to the digester blowdowns at the Great Lakes Forest Products company.

In order to further ascertain the source of the SO_2 concentrations, a correlation analysis between SO_2 and H_2S was performed for this monitoring period. (Thunder Bay #53, see Figure #16, page 65) With 59 degrees of freedom, the correlation coefficient (0.64) was significant to the 99.9% confidence level. This implied a mutual source for SO_2 and TRS - namely the pulp mill.

Nitrogen Dioxide - NO_2

The Great Lakes Forest Products company was not a suspected major source of NO_2 . The analysis of the acquired NO_2 glc data substantiated this assumption (Refer to statistical summary Table #7c, pages 91 to 95). From the 460 hours of acquired NO_2 data, based on 61 monitoring periods whose duration greater than 1½ hours, the overall average glc was 0.027 ppm with an associated standard deviation 0.014 ppm.

Since no singular, discrete source(s) could be determined for this contaminant, ambient air quality Criteria were followed in the assessment of the acquired data. This maximum 60-minute average glc was 0.107 ppm and was detected on August 12 during MP Thunder Bay #23. As noted in the concentration/time analysis for this MP (Figure #3 on page 52), based on 60-minute running averages, the winds were calm and a subsidence inversion was present during this night-time monitoring. The NO_2 concentration data depicted by Figure #3 denotes a uniform concentration, implying no singular source.

The vehicular traffic contribution to oxides of nitrogen (NO_x) is noted by the relative increase in nitric oxide (NO). For example, the maximum instantaneous NO glc detected was during MP Thunder Bay #19 on August 10th and its value was 0.427 ppm (see Figure #4, page 53). The MAM unit was located at the Can-Car parking lot and the glc increase was noted after 0700 (EDT) hours.

A correlation analysis between NO_2 and H_2S for MP Thunder Bay #53 was performed to aid in source identification (see Figure #17, page 66). The resulting correlation coefficient (-0.35) for 29 degrees of freedom was insignificant, implying that no mutual source(s) for these contaminants existed in this area.

Ozone - O_3

Similar to the NO_2 discussion, the Great Lakes Forest Products company was not a suspected source of ozone. From over 460 hours of acquired O_3 glc data, the overall average glc was 0.023 ppm with an associated standard deviation 0.018 ppm.

As noted by the statistical summary Table #7d, pages 96 to 100, the maximum 60-minute average glc for O_3 was 0.082 ppm and this was the only excursion above the Criterion (0.08 ppm). This elevated glc was detected during MP Thunder Bay #16 on August 7th. (See Figure #5, page 54.)

Hi-Volume Analysis

Five standard hi-volume samplers with glass fibre-filters and two standard hi-volume samplers with Delbag-microsorban filters were utilized to establish ambient air mass loadings in the vicinity of Great Lakes Forest Products Limited, Thunder Bay. The samplers were placed around this plant with three of the five glass fibre filter units and the two Delbag-microsorban filter units placed in areas of highest population concentration to the northeast (refer to Map #9 on page 29).

Between August 1 and 24th, 109 glass fibre- filters were collected and later analyzed for total suspended particulate matter (TSP) and iron (Fe) mass loadings. These results are listed in Table #11, pages 113 through 121. In addition, 43 Delbag-

microsorban filters were exposed and subsequently analyzed for sulphates ($\text{SO}_4^{=}$), nitrates (NO_3), silicon (Si) and iron (Fe) mass loadings. These results are also listed in Table #11, pages 113 through 121. Information regarding the prevailing wind direction and speed was obtained from the Atmospheric Environment Service in Thunder Bay.

a) Total Suspended Particulates (TSP):

Of the 109 samples, 20 were found to have TSP loadings in excess of the ambient air quality Criterion of 120 ug/m^3 based on a 24-hour sampling period. The maximum concentration of TSP occurred on August 9 at the Dow Chemical site, ENE of Great lakes Forest Products. The concentration was 296 ug/m^3 and the winds, on the average, for this date were from the west at approximately 13 km/hr. Also on this day, two other sites reported mass loadings in excess of the Criterion; one of which was also in a location downwind of the pulp mill. The average loading for August 9 was 177 ug/m^3 which was the highest daily average recorded.

The overall average TSP loading was 72 ug/m^3 with an associated standard deviation of 57 ug/m^3 .

b) Iron - (Fe)

The overall average loading of Fe was 3.2 ug/m^3 with a standard deviation of 3.1 ug/m^3 . Therefore, approximately 4% of the TSP loading was composed of Fe. The maximum concentration was 18.7 ug/m^3 which was acquired on August 4 at the Dow Chemical site. Winds at this time were from the WSW at 19 km/hr.

c) Silicon - Si

The Delbag-microsorban filters were analyzed for Si content and the overall average concentration was found to be 17.6 ug/m^3 and was acquired with an associated standard deviation of 19.1 ug/m^3 . Based on a 24 hour sampling time, the maximum concentration of Si was found to be 75.7 ug/m^3 and was acquired at the Dow Chemical site on August 10. Winds during this period were from the south at 8 km/hr.

(The silica (SiO_2) mass loadings may be obtained from the Si mass loadings by multiplying the values by the ratio of molecular weights: $\text{MWt}(\text{SiO}_2)/\text{MWt}(\text{Si}) = 2.14$.)

d) Sulphates - $\text{SO}_4^{=}$

The overall average $\text{SO}_4^{=}$ content was 6.2 ug/m^3 with a standard deviation of 5.5 ug/m^3 . On August 14, the maximum glc of $\text{SO}_4^{=}$ occurred, the value being 22.1 ug/m^3 , and was acquired at the Dow Chemical site. Winds during this 24 hour period (beginning at 1230 (EDT) on August 14) were reported by the MAM unit (see addendum MP's Thunder Bay #26, 27 and 28) and were found to be from the SSW at approximately 15 km/hr. Therefore the Hi-Volume sampling site was in a downwind position with respect to the Great Lakes Forest Products company.

e) Nitrates - NO_3

The overall average content of NO_3 was 0.5 ug/m^3 with a standard deviation of 0.8 ug/m^3 . The maximum concentration was 3.9 ug/m^3 and was acquired on August 7 at the Dow Chemical site. The sampling site was again in a downwind position with respect to Great Lakes Forest Products as the winds were from the SW at approximately 11 km/hr.

f) Iron - Fe

The Delbag-microsorban filters were also analyzed for Fe content. The overall average and standard deviation were 4.1 ug/m^3 and 4.2 ug/m^3 respectively which compared very well with the results obtained from the glass-fibre filter analysis. The maximum concentration found was 18.9 ug/m^3 and was acquired during August 12 at the Dow Chemical Site. Winds were from the SW at approximately 8 km/hr.

Tracor Analysis

In Thunder Bay, 29 ambient air samples collected in polyester Mylar bags were analyzed by the Tracor unit. The relative concentrations of the various sulphur compounds were found to be:

H₂S (& COS) - 12%

MeSH - 35%

EtSH (& (CH₃)₂S) - 52%

(See also Tables #12 to #14, pages 122 to 126.)

(ii) Red Rock

Over 41 hours of glc data were acquired during August 26 and 27 by the MAM unit in the vicinity of the Domtar Packaging Company.

Total Reduced Sulphur - TRS

Approximately 10% of the acquired TRS glc data (4 hours out of 41 hours) resulted in 30-minute average glc's in excess of the Guideline (0.027 ppm). The overall average TRS glc was 0.012 ppm with an associated standard deviation 0.007 ppm. (See the statistical summary Table #8a, page 101.)

The maximum 30-minute average TRS glc was 0.13 ppm (greater than four times the Guideline) and was recorded on August 27 during MP Red Rock #5 - refer to Figure #6 on page 55. Upon arrival of the MAM unit in Red Rock on this date (1030 hours EDT), fumigation from the Domtar kraft pulp mill was observed by the MOE field personnel throughout the downtown sector. During the beginning of this MP, the winds were easterly and brisk (approximately 12 km/hr). A warm front was pushing into this area bringing overcast and stagnant weather conditions during the evening and the following day (see Red Rock #3, #4 and #5 concentration/time graphs in Figures #7, #8 and #6, pages 56, 57, and 55). Entrainment through orographic lift, induced by Red Rock Hill and the approaching warm front trapped the emissions from this kraft pulp mill in the downtown sector of Red Rock through the formation of a vertical flow cell. This phenomenon explains the

wind/concentration rose analysis (Map #11, page 73) depicting the area of maximum TRS contribution as being ENE of the Red Rock Inn.

The second highest maximum 30-minute average TRS glc was 0.028 ppm and was recorded on the same day during M.P. Red Rock #3 (Table #8a, page 101). The MAM unit was located just outside the main entrance to the kraft pulp mill and in the impingement zone as noted by the MOE field operators. The wind/concentration rose analysis (Map #12 on page 74) clearly shows the entrainment feature of Red Rock Hill mentioned in the preceding paragraph.

Sulphur Dioxide - SO₂

As expected, very little sulphur dioxide was detected in Red Rock. The overall average glc of SO₂ (from 41 hours of accumulated data) was 0.003 ppm with an associated standard deviation 0.001 ppm. The largest maximum 30-minute average SO₂ glc was 0.009 ppm and was recorded during MP Red Rock #5 on August 27. A summary of the statistical results for SO₂ is presented in Table #8a, page 101.

Nitrogen Dioxide - NO₂

Domtar was not a suspected source of NO₂, and low glc's of this contaminant were detected during this segment of this northwest survey. (See Table #8c, page 103.) From the 41 hours of acquired NO₂ glc data, the overall average glc was 0.026 ppm with an associated standard deviation 0.018 ppm.

The 60-minute NO₂ Criterion (0.20 ppm) was never exceeded. The largest maximum 60-minute average NO₂ glc was 0.064 ppm and was recorded during MP Red Rock #1. As noted in the concentration/time analysis (Figure #9, page 58), the NO₂ glc was essentially uniform throughout this monitoring period. The winds were light and southerly.

Ozone - O₃

Low glc's of ozone were detected in Red Rock. The overall average glc and

standard deviation were 0.026 ppm and 0.006 ppm respectively. At no time was the 60-minute O_3 Criterion exceeded during this survey as the maximum 60-minute average O_3 glc was 0.032 ppm. (Refer to the statistical summary Table #8d, page 104.)

Tracor Analysis

In Red Rock, 8 ambient air samples were analyzed by the Tracor unit. The relative concentrations of the sulphur compounds were:

H_2S (& COS) - 86%

MeSH - 9%

EtSH (& $(CH_3)_2S$) - 4%

(See also Tables #12 to #14, pages 122 to 126.)

iii) Marathon

Between August 29 and September 1, over 35 hours of glc data were collected at 6 different monitoring sites in the vicinity of the American Can Canada Inc. kraft pulp mill.

Total Reduced Sulphur - TRS

Significant glc's of TRS were collected during this survey. From the 35 hours of acquired TRS glc data, the overall average glc was 0.019 ppm with an associated standard deviation 0.007 ppm. The TRS 30-minute Guideline (0.027 ppm) was exceeded during 4 of the 6 MP's for a total of over 8 hours; approximately 25% of the total monitoring time. The remaining two MP's reported maximum 30-minute glc averages of 0.026 ppm. (Refer to the statistical summary Table #9a, page 105.)

The maximum 30-minute average TRS glc was 0.073 ppm (over 2½ times the TRS Guideline) and was recorded at the water tower in downtown Marathon on August 29. Refer to the concentration/time graph MP Marathon #4, Figure #10 on page 59. The wind/concentration rose (Map #13 on page 75) clearly denotes the American Can Canada Inc. kraft pulp mill as being the only plausible source of this contaminant. The maximum instantaneous TRS glc for this MP was 0.132 ppm, the highest for this part of the NW survey.

Monitoring sites #6 and #7 were located along Highway #17, approximately 5½ to 7 km NNE of the kraft pulp mill. During the night of August 31 (MP #6) and the day of September 1st (MP #7), significant glc's of TRS were monitored at these locations with the maximum 30-minute average glc's being 0.044 ppm and 0.038 ppm respectively. (See Figures #11 and 12, pages 60 and 62.) On shore flows were induced by the Lake Superior/land temperature gradient. Since the area was under the influence of a high pressure ridge, the on shore flow and subsequent channelling along the Angler Creek valley caused significant impingement of the mill emissions along Highway #17. Due to this phenomenon, visibility in the impingement zone along Highway #17 was reduced to less than 1 km. The concentration/wind rose analysis for MP Marathon #6, Map #14, page 76, pointed to the SW sector which indicated American Can Canada Inc. as the major source of this contaminant.

Sulphur Dioxide - SO₂

Low glc's of SO₂ were detected in Marathon. For a summary of the statistical results, refer to Table #9a on page 105. From the 35 hours of acquired data, the overall average SO₂ glc was 0.018 ppm with an associated standard deviation 0.006 ppm. The largest maximum 30-minute average SO₂ glc was 0.05 ppm (17% of the Standard) and was recorded during MP Marathon #5 on August 31. (See Figure #13, page 62.)

Correlation analyses between SO₂ and H₂S glc's were performed for MP's Marathon #4 and #6. (Refer to Figures #18 and #19 on pages 67 and 68.) Excellent correlations were found between these two contaminants. For 46 and 79 degrees of freedom (#4 and #6 respectively), the correlation coefficients were 0.81 and 0.82 respectively which were significant at the 99.9% confidence level. This result suggested that although the glc's of SO₂ were low, the origin of SO₂ was the same as that for TRS, namely the American Can Canada Inc. kraft pulp mill.

Nitrogen Dioxide - NO₂

From the 35 hours of acquired NO₂ glc data, the 60-minute

Criterion was never exceeded. Low glc's of NO_2 were detected and the overall average glc was 0.015 ppm with an associated standard deviation 0.005 ppm. (Refer to statistical summary Table #9c , page 107.)

The maximum 60-minute average NO_2 glc was 0.027 ppm (approximately 10% of the Criterion) and was recorded during the afternoon of September 1.

A correlation analyses between the glc's of NO_2 and H_2S was carried out in order to ascertain any mutual origin of these two contaminants in this area. As noted in Figure #20 on page 69 for MP Marathon #4, no correlation was found since a correlation coefficient of 0.07 was determined for 21 degrees of freedom. Therefore the NO_2 glc in this area was deemed to be mainly of an extraneous origin - long range transport, etc.

Ozone - O_3

Ozone data was collected solely for a Regional data bank. As expected, only background concentrations of this contaminant were detected and the Criterion (0.08 ppm) was never exceeded. (Refer to Table #9d, page 108 for the statistical summary.)

The overall average O_3 glc was 0.023 ppm with an associated standard deviation 0.007 ppm. The largest maximum 60-minute average was 0.04 ppm (50% of the Criterion) and was acquired during Marathon #7 on September 1.

Tracor Analysis

In Marathon, 6 ambient air samples were analyzed by the Tracor unit. The relative concentrations were:

H_2S (& COS) - 41%

MeSH - 37%

EtSH (& $(\text{CH}_3)_2\text{S}$) - 22%

(See also Tables #12 to #14, pages 122 to 126.)

iv) Terrace Bay

Approximately 39 hours of glc data were acquired by the MAM unit at three different monitoring sites in the vicinity of the Kimberly-Clark of Canada Limited

kraft pulp mill during the period August 28 to September 1. During the time of this survey, the production of the kraft pulp mill was fluctuating substantially. For this reason, as can be seen by the number of monitoring periods, only a short period of time was spent monitoring this area.

Two sources were considered during the assessment of this glc data. These were the kraft pulp mill and its effluent ditch running parallel to Highway #17. (Refer to Map #4, page 12.)

Total Reduced Sulphur - TRS

For the 39 hours of TRS data, the overall average glc was 0.024 ppm with an associated standard deviation 0.032 ppm. The statistical results for TRS are summarized in Table #10a, page 109.

(a) Kraft Pulp Mill

From the 31 hours of TRS glc data acquired during MP's Terrace Bay #1 and #3, located downwind of this mill, approximately 6 hours of data (20%) resulted in concentrations in excess of the 30-minute Guideline - i.e. 0.027 ppm.

As noted in the statistical summary table, the largest maximum 30-minute average glc was 0.30 ppm and was acquired near the clarifier and settling pond located approximately 1.1 km to the NE of the mill (MP Terrace Bay #3, see Figure #4, page 63). The winds were from the S to SW at approximately 8 km/hr and the wind/concentration rose analysis (Map #15 on page 77) clearly points to the Kimberly-Clark mill as the major source of this contaminant.

(b) Effluent Ditch

No significant glc's of TRS were recorded during MP Terrace Bay #2 on August 30. The MAM unit was located at the first effluent crossing on Highway #17, and the winds were southwesterly and light. The maximum 30-minute average TRS glc detected at this site was 0.006 ppm. (See Figure #15, page 64.)

Sulphur Dioxide - SO₂

Relatively low concentrations of SO₂ were recorded in the vicinity of the kraft pulp mill. The overall average glc was 0.009 ppm with an associated standard deviation of 0.004 ppm. The maximum 30-minute average glc of SO₂ recorded was 0.047 ppm (16% of the SO₂ Standard on August 28-Terrace Bay #1). During this time, the MAM unit was located at the Moose Lodge parking lot, approximately 1 km from the Kimberly-Clark kraft pulp mill. Correlation analyses between SO₂ and TRS were carried out for MP's Terrace Bay #1 and #3 (see Figures #21 and #22, pages 70 and 71). The correlation coefficients (0.90 and 0.73 for 69 and 53 degrees of freedom respectively) were significant at the 99.9% confidence level -implying a mutual origin; the kraft pulp mill.

As noted in the statistical summary Table #10a, page 109, the maximum 30-minute average SO₂ glc (MP Terrace Bay #2) acquired in the vicinity of the first effluent crossing on Highway #17 was 0.011 ppm - 4% of the standard. (See Figure #15, page 64.)

Nitrogen Dioxide - NO₂

The Kimberly-Clark kraft pulp mill was not a suspected source of NO₂. As noted in the statistical summary table (Table #10c on page 111) low glc's of NO₂ were detected downwind of the mill site (maximum 60-minute average NO₂ was 0.046 ppm), however a larger glc was found at the first effluent crossing on Highway #17 (60-minute average was 0.068 ppm, approximately 34% of the Criterion). These NO₂ glc's were low and were essentially the same as those determined for Marathon and Red Rock. The overall average NO₂ glc and associated standard deviation were 0.016 ppm and 0.005 respectively (based on the 60 minute averaged values).

With respect to the effluent crossing, the 30-minute Standard for oxides of nitrogen (NO_x) was exceeded for a period of approximately 15 minutes. As noted in the concentration/time analysis (Terrace Bay #2, Figure #15 on page 64), the maximum 30-minute average NO_x glc was 0.28 ppm and was recorded under calm conditions.

NO was the major component of NO_x at this time and as a result, vehicular exhaust was deemed to be the major source.

Ozone - O_3

The kraft pulp mill was not a suspected source of O_3 however this data was collected in order to establish a Regional data bank for this area. These results are presented in Table #10d on page 112.

Low glc's of O_3 were detected. The overall average O_3 glc was 0.036 ppm with an associated standard deviation 0.016 ppm. The maximum 60-minute average glc was 0.053 ppm (approximately 66% of the Criterion) and was recorded during MP Terrace Bay #3, on September 1.

Tracor Analysis

Only a single ambient air sample was collected in Terrace Bay and analyzed by the Tracor unit. The analysis showed that the relative concentrations of the reduced sulphur compounds, were:

H_2S (& COS) - 23%

MeSH - 38%

EtSH (& $(\text{CH}_3)_2\text{S}$) - 38%

(See Tables #12 to #14, pages 122 to 126.)

(iv) Summary of Tracor Results

For the entire 44 air samples acquired and analyzed for this northwest region survey, the relative concentrations of the reduced sulphur compounds were:

H_2S (& COS) - 45%

MeSH - 29%

EtSH (& $(\text{CH}_3)_2\text{S}$) - 26%

As suspected, the mercaptan contribution to the total reduced sulphur (TRS) concentrations was significant, accounting for approximately 55%.

09. Appendix

a) Figures:

- #1 H_2S , SO_2 & NO_x concentration/time analysis for Thunder Bay #16
- #2 H_2S , SO_2 , & NO_x concentration/time analysis for Thunder Bay #53
- #3 O_3 & NO_2 concentration/time analysis for Thunder Bay #23
- #4 NO_x , NO , & O_3 concentration/time analysis for Thunder Bay #19
- #5 H_2S , NO_x , & O_3 concentration/time analysis for Thunder Bay #16
- #6 H_2S , SO_2 & NO_x concentration/time analysis for Red Rock #5
- #7 H_2S , SO_2 & NO_x concentration/time analysis for Red Rock #3
- #8 H_2S , SO_2 , & NO_x concentration/time analysis for Red Rock #4
- #9 O_3 & NO_2 concentration/time analysis for Red Rock #1
- #10 H_2S , SO_2 & NO_x concentration/time analysis for Marathon #4
- #11 H_2S , SO_2 & NO_x concentration/time analysis for Marathon #6
- #12 H_2S , SO_2 & NO_x concentration/time analysis for Marathon #7
- #13 H_2S , SO_2 & NO_x concentration/time analysis for Marathon #5
- #14 H_2S , SO_2 & NO_x concentration/time analysis for Terrace Bay #3
- #15 H_2S , SO_2 & NO_x concentration/time analysis for Terrace Bay #2
- #16 SO_2 vs H_2S correlation plot for Thunder Bay #53
- #17 NO_2 vs H_2S correlation plot for Thunder Bay #53
- #18 SO_2 vs H_2S correlation plot for Marathon #4
- #19 SO_2 vs H_2S correlation plot for Marathon #6
- #20 NO_2 vs H_2S correlation plot for Marathon #4
- #21 SO_2 vs H_2S correlation plot for Terrace Bay #1
- #22 SO_2 vs H_2S correlation plot for Terrace Bay #3

b) Maps:

- #10 H_2S Wind-Rose for Thunder Bay #16
- #11 H_2S Wind-Rose for Red Rock #5
- #12 H_2S Wind-Rose for Red Rock #3
- #13 H_2S Wind-Rose for Marathon #4
- #14 H_2S Wind-Rose for Marathon #6
- #15 H_2S Wind-Rose for Terrace Bay #3

c) Graphs:

- #1 Calibration curve for hydrogen sulphide and methyl mercaptan
- #2 Calibration curve for ethyl mercaptan
- #3 Calibration curve for carbon disulphide

d) Tables:

1) Thunder Bay statistics

- #7a H_2S & SO_2 30-minute average
- #7b NO_x & O_3 30-minute average
- #7c NO_2 & NO 60-minute average
- #7d O_3 60-minute average

2) Red Rock statistics

- #8a H_2S & SO_2 30-minute average
- #8b NO_x & O_3 30-minute average
- #8c NO_2 & NO 60-minute average
- #8d O_3 60-minute average

3) Marathon statistics

- #9a H_2S & SO_2 30-minute average
- #9b NO_x & O_3 30-minute average
- #9c NO_2 & NO 60-minute average
- #9d O_3 60-minute average

4) Terrace Bay statistics

- #10a H_2S & SO_2 30-minute average
- #10b NO_x & O_3 30-minute average
- #10c NO_2 & NO 60-minute average
- #10d O_3 60-minute average

#11 Hi-Volume Analysis (glass-fibre filter and Delbag-Microsorb filter)

#12 Tracor Sampling Statistics

#13 Statistical Summary of Sulphur Analysis

#14 Sulphur Analysis (Tracor) results

THUNDER BAY #16

18:01 AUG 7 1978

SCAN= 60 SEC

AVE= 30 MIN

PLANT SIGN (X2910-Y5810): 0.7KM & 355 DEG/SEC

0.033
28
58
987

0.033
28
57
987

0.021
28
57
986

0.019
28
58
986

0.013
27
64
986

SRAD W/CH2
TEMP DEG C
HUM % REL
PRES MBAR

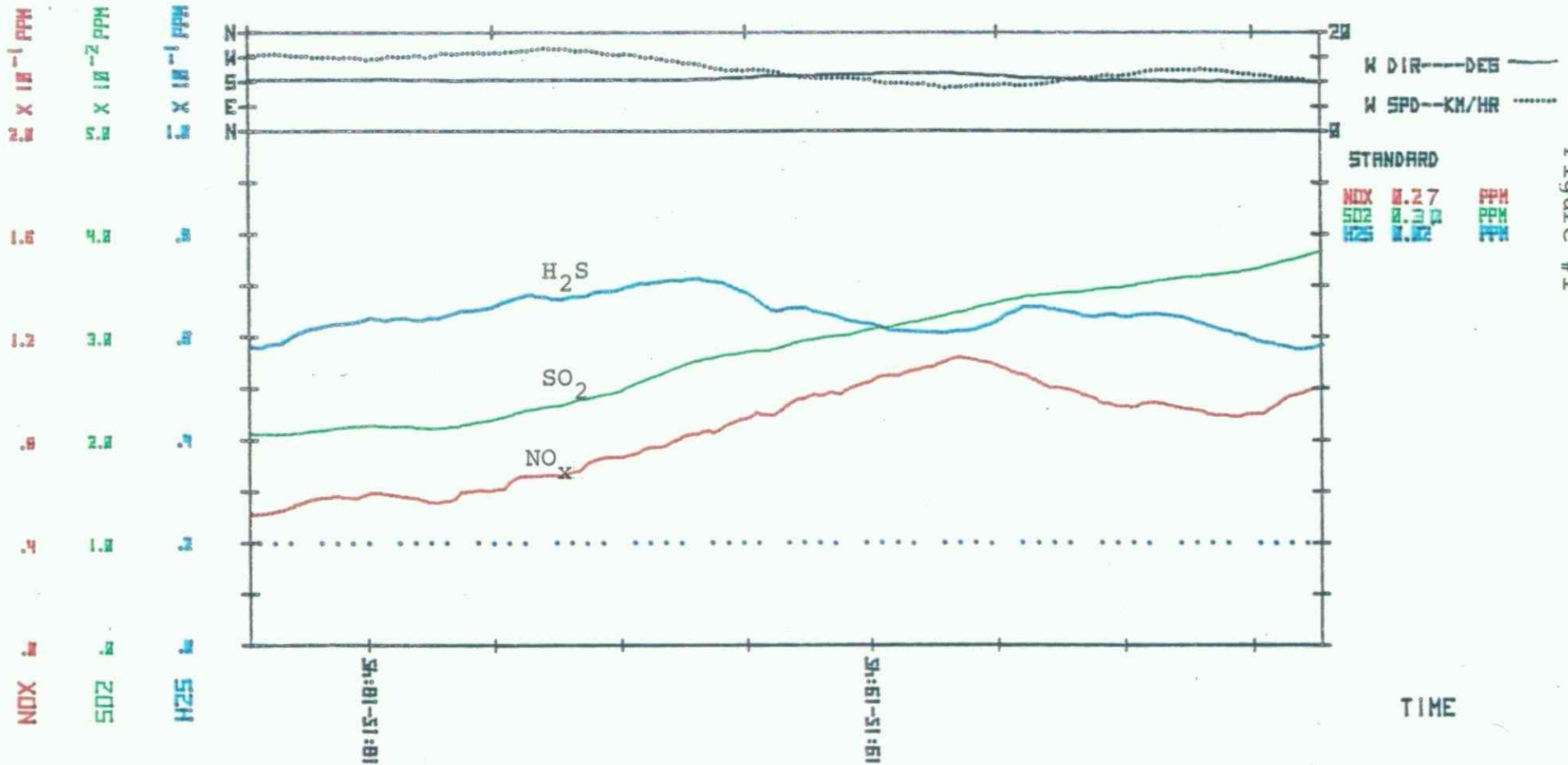


Figure #1

THUNDER BAY #53

17:45 SEP 3 1978

SCAN= 150 SEC

AVE= 30 MIN

MONTREAL & NEEBING STS. (X2928-Y5838); 1.0KM & 005 DEG/SEC

0.040	0.011	0.000	0.000	0.000	0.000	0.000	0.002	SRAD	W/CM2
21	18	14	13	11	10	11	12	TEMP	DEG C
65	66	68	68	68	68	68	68	HUM	% REL
996	995	994	993	992	992	991	991	PRES	MBAR

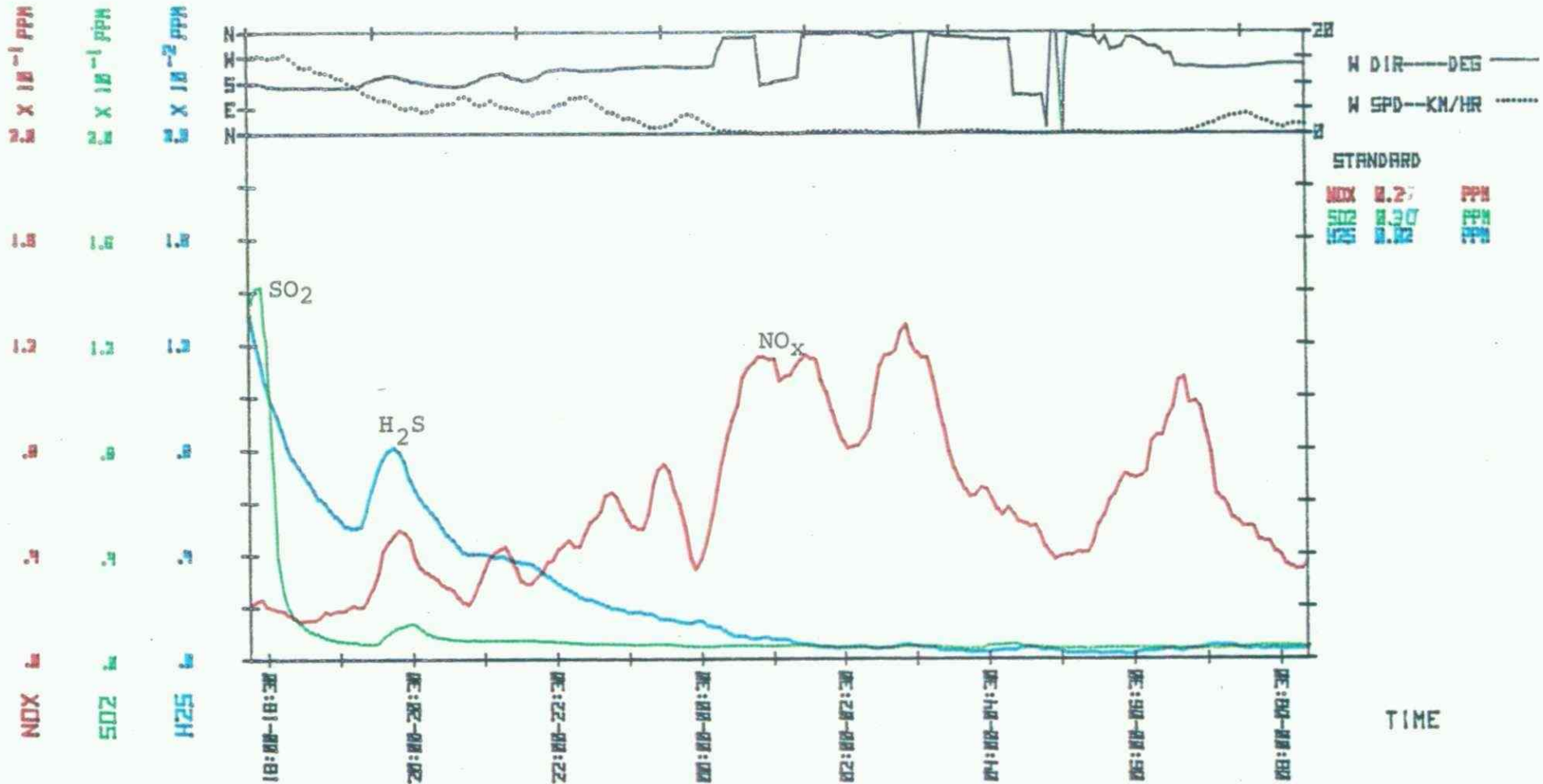


Figure #2

THUNDER BAY #23

22:14 AUG 12 1978

SCAN= 158 SEC

AVE= 68 MIN

CHN-CFR (X2958-Y5848); 1.1KN & 125 DBS/SEC

H.000
25
100
995

H.000
21
100
996

H.000
19
100
997

H.000
18
100
998

H.000
18
100
999

H.012 SRAID H/CH2
21 TEMP DEG C
100 HUM % REL
992 PRES MBAR

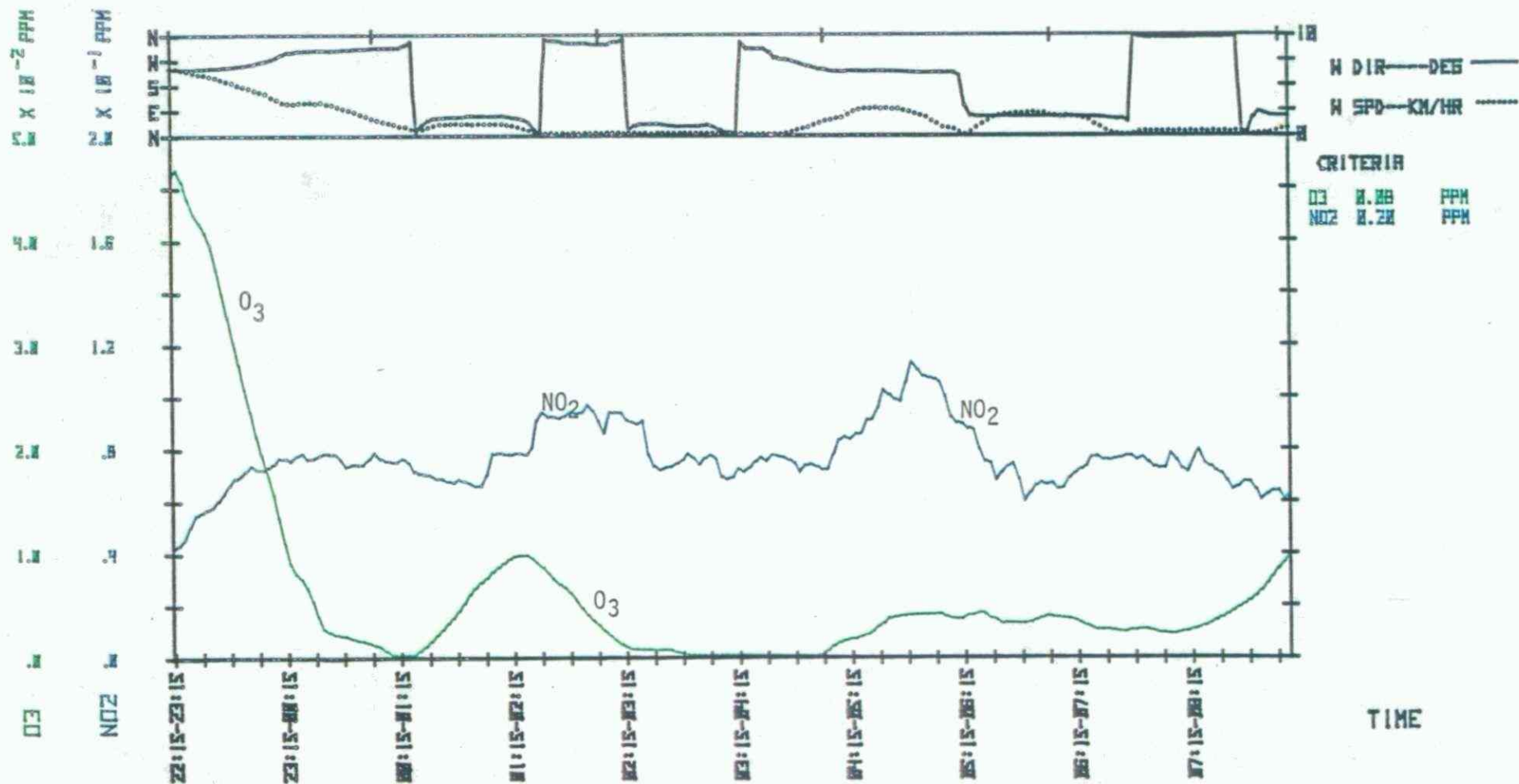


Figure #3

AVE ⇒ ~~EN~~ MIN

CHN-CHR (XZ5678-Y5846); 1.1KM & 1725 DEG/5RC

0.005	SRAD	M/CHZ
16	TEMP	DEG C
100	HUM	% REL
999	PRES	MMHG



THUNDER BAY #16

18:01 AUG 7 1978

SCAN= 60 SEC

AVE= 60 MIN

PLANT SIGN (X2910-Y5810); 0.7KM & 355 DEG/SRC

0.033
28
57
987

0.027
28
57
986

0.020
28
58
986

0.016
27
61
986

SRAD W/CH2
TEMP DEG C
HUM % REL
PRES MBAR

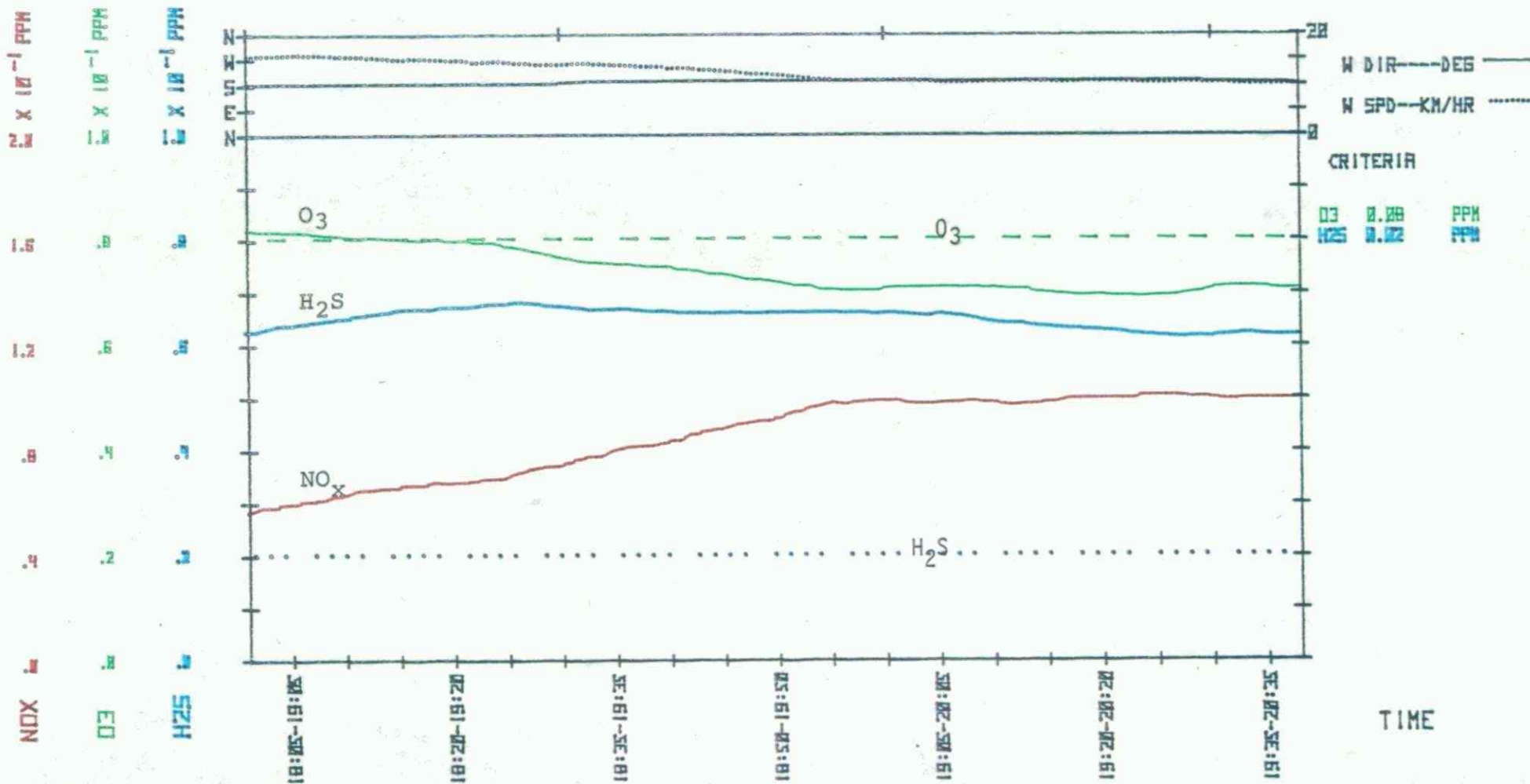


Figure #5

RED ROCK #5

16:12 AUG 27 1978

SCAN= 150 SEC

AVE= 30 MIN

RED ROCK NN (X8785-Y2185); 1KM & 310 DEG/SRC

0.005
18
100
985

0.002
17
100
986

0.000
17
100
986

0.000
17
100
983

0.000
17
100
982

SRAD W/CM2
TEMP DEG C
HUM % REL
PRES MBAR

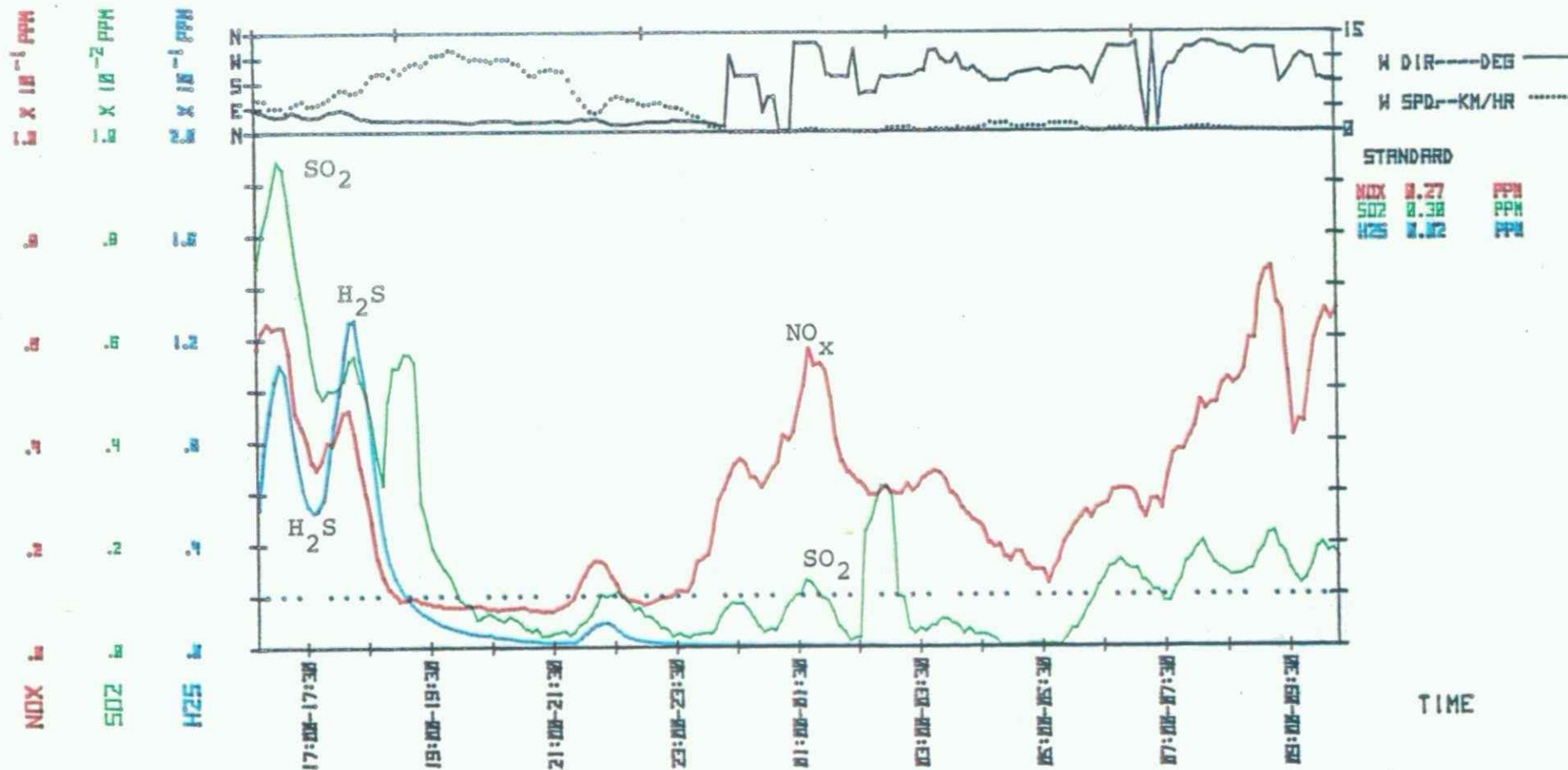


Figure #6

RED ROCK #3

11:27 AUG 27 1978

SCAN= 30

SEC

AVE= 30

MIN

0.1KM E OF FENCE, 0.1KM SE OF ESSO (X0035-Y2150); 0.5KM & 340 DEG/SRC

0.007
17
100
992

0.008
17
100
992

SRAD W/CM2
TEMP DEG C
HUM % REL
PRES MBAR

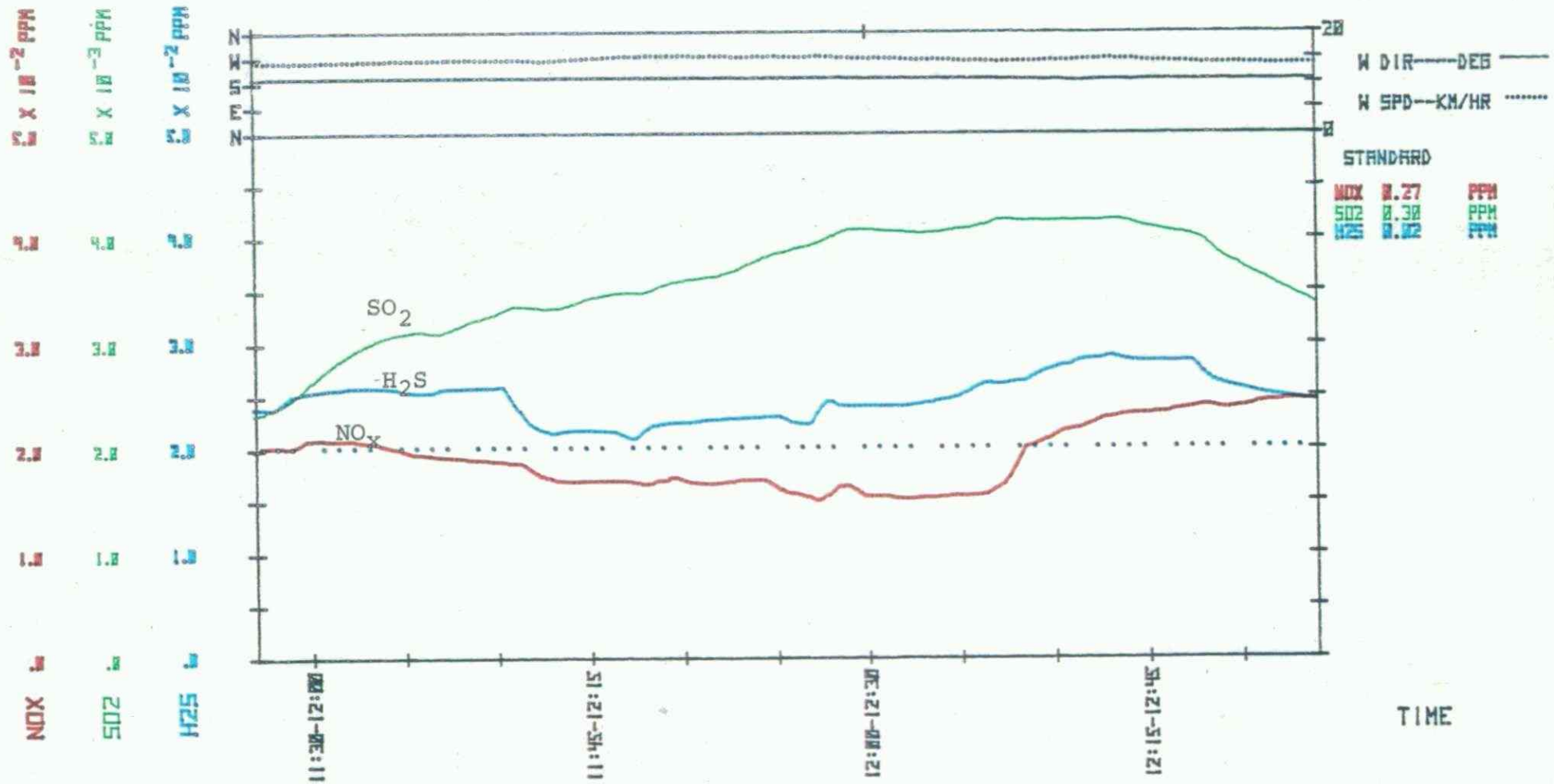


Figure #7

RED ROCK #4

13:25 AUG 27 1978

SCAN= 90

SEC

AVE= 30

MIN

2.4KM N OF HWY #62B ON RED ROCK RD #1 (X0550-Y2415) SKM & 310065/SRC

0.006
17
100
982

0.004
17
100
982

0.006
17
100
981

0.006
17
100
981

SRAD W/CM2
TEMP DEG C
HUM % REL
PRES MBAR

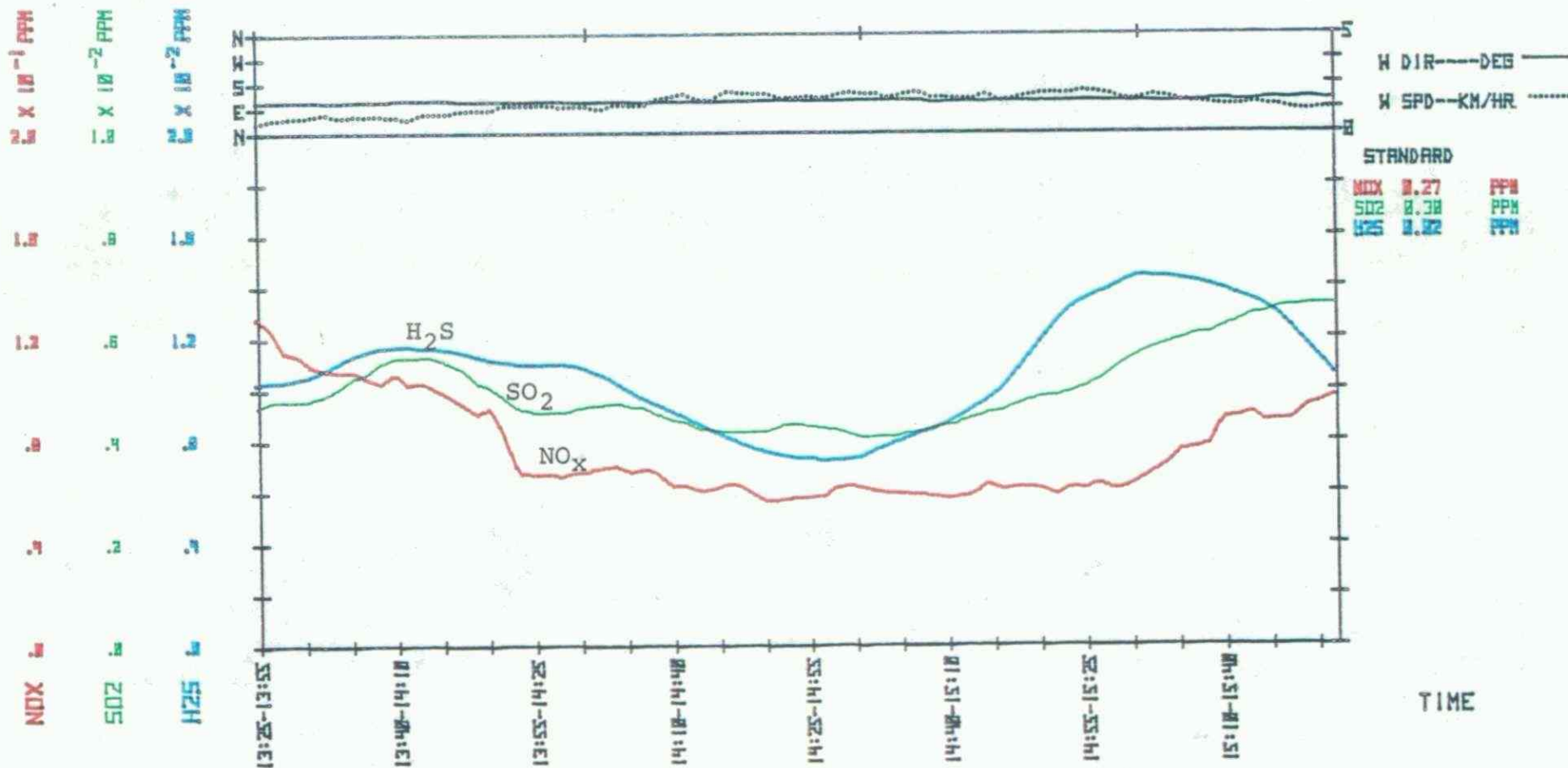


Figure #8

RED ROCK #1

13:53 HUS 26 1978

SEC	AVE	MIN
50	50	50

HWY #17, 1.50M N OF GOLF CLUB RD (X0208-Y2585); 80M & 31M DEE/SRC

四.四一三
 一八
 一四四
 五五

SRAD	H/CHZ
TEMP	DEG C
HUM	% REL
PRES	MMHG

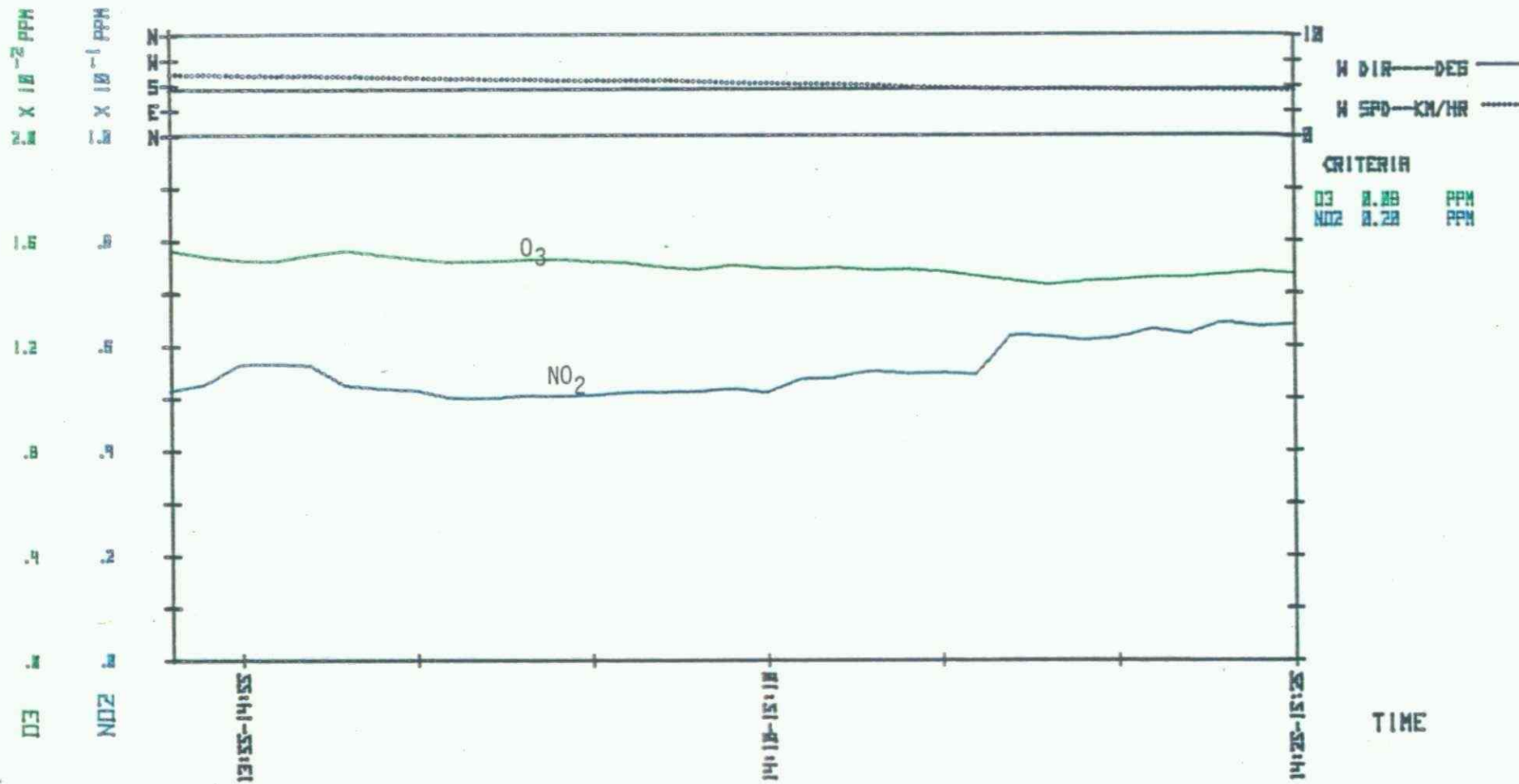


Figure #9

MARATHON #4

17:02 AUG 29 1978

SCAN= 120 SEC

AVE= 30 MIN

WATER TOWER IN DOWNTOWN MARATHON (X4545-Y9615); 1.0KM & 090 DEG/SEC

0.039
18
100
983

0.005
14
100
984

0.000
14
100
987

0.000
9
100
991

0.003
7
100
994

SRAD W/CH2
TEMP DEG C
HUM % REL
PRES MBAR

NOX
SO2
H2S

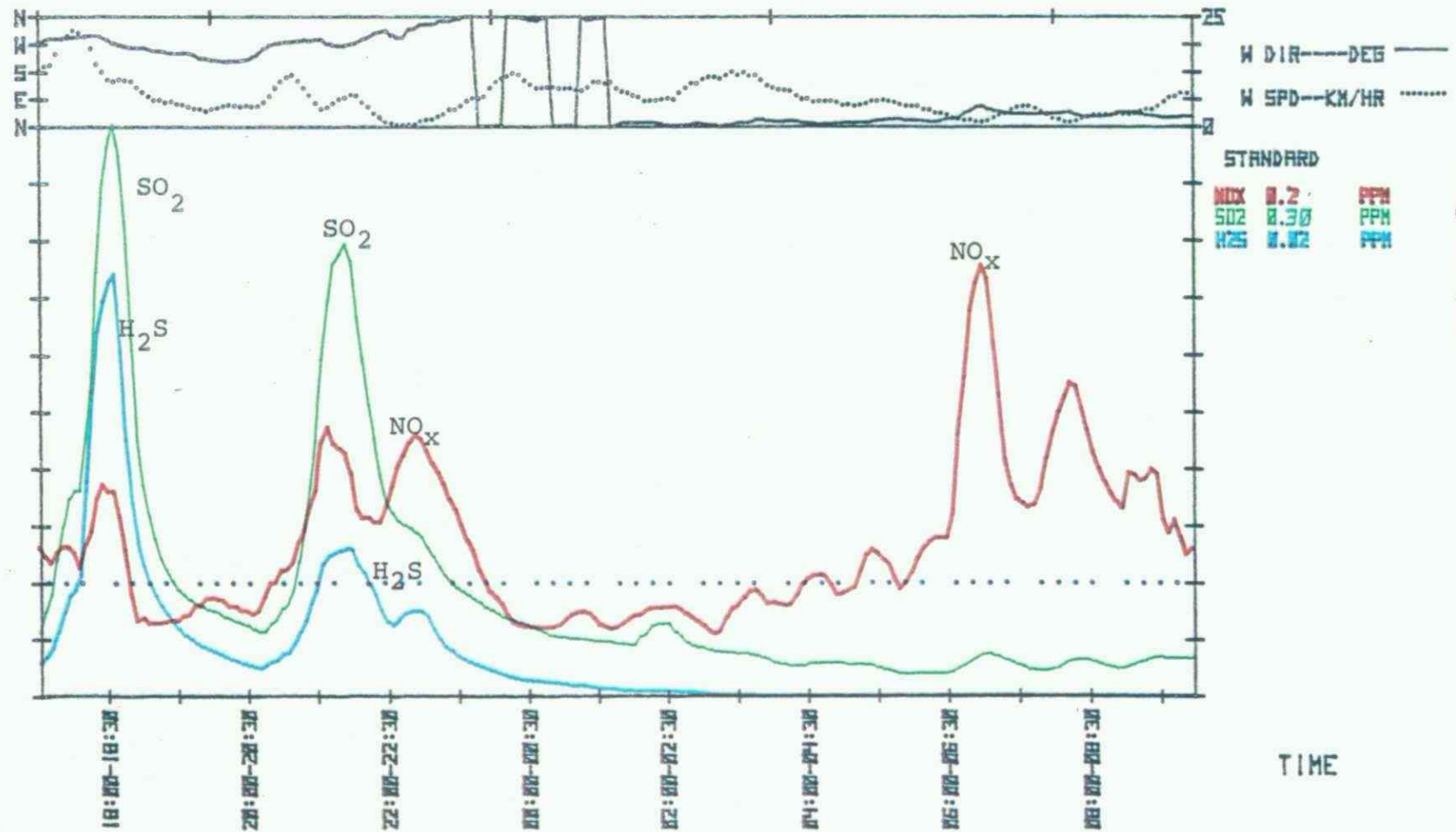


Figure #10

MARATHON #6

21:22 AUG 31 1978

SCAN= 150 SEC

AVE= 30 MIN

OPP STATION ON HWY #17 (X4700-Y0100); 5.5KM @ 025 DEG/SAC

0.000
11
100
983

0.000
11
100
983

0.000
11
100
983

0.000
11
100
983

0.000
11
100
983

0.000
11
100
983

SRAD W/CM2
TEMP DEG C
HUM % REL
PRES MBAR

NOX
502
H2S
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0
30.0
31.0
32.0
33.0
34.0
35.0
36.0
37.0
38.0
39.0
40.0
41.0
42.0
43.0
44.0
45.0
46.0
47.0
48.0
49.0
50.0
51.0
52.0
53.0
54.0
55.0
56.0
57.0
58.0
59.0
60.0
61.0
62.0
63.0
64.0
65.0
66.0
67.0
68.0
69.0
70.0
71.0
72.0
73.0
74.0
75.0
76.0
77.0
78.0
79.0
80.0
81.0
82.0
83.0
84.0
85.0
86.0
87.0
88.0
89.0
90.0
91.0
92.0
93.0
94.0
95.0
96.0
97.0
98.0
99.0
100.0

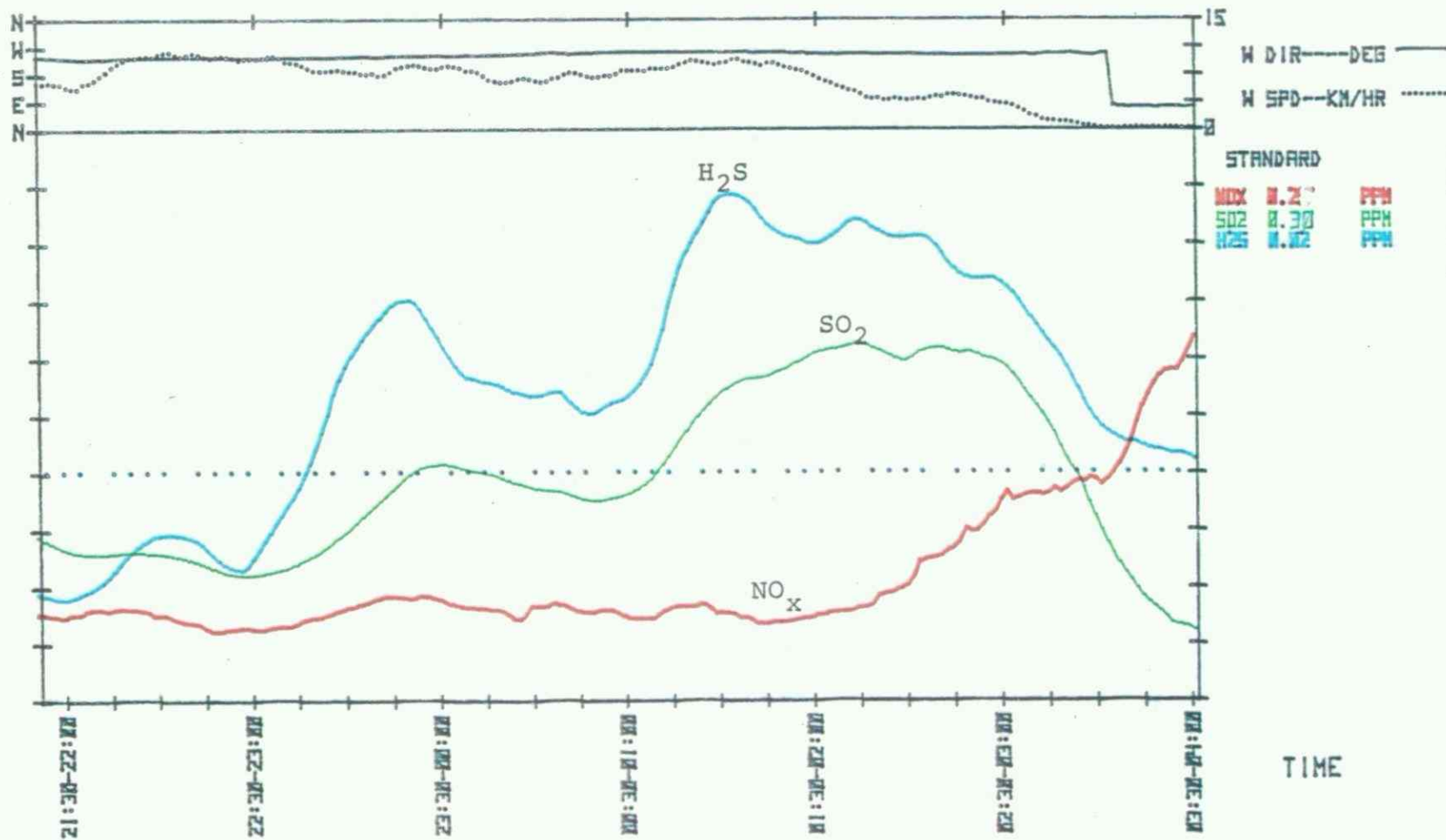


Figure #11

MARATHON #7

14:12 SEP 1 1978 SCAN= 60 SEC AVE= 30 MIN
0.8KM W OF ANGLERS CREEK ON HWY #17 (X4275-Y0285); 7.0KM @ 345 DEG/SEC

0.029
19
100
987

0.020
18
100
987

0.014
18
100
986

0.009
17
100
986

SRAD W/CH2
TEMP DEG C
HUM % REL
PRES HBAR

NOX 1.0 X 10⁻² PPM
SO2 1.0 X 10⁻² PPM
H2S 1.0 X 10⁻² PPM

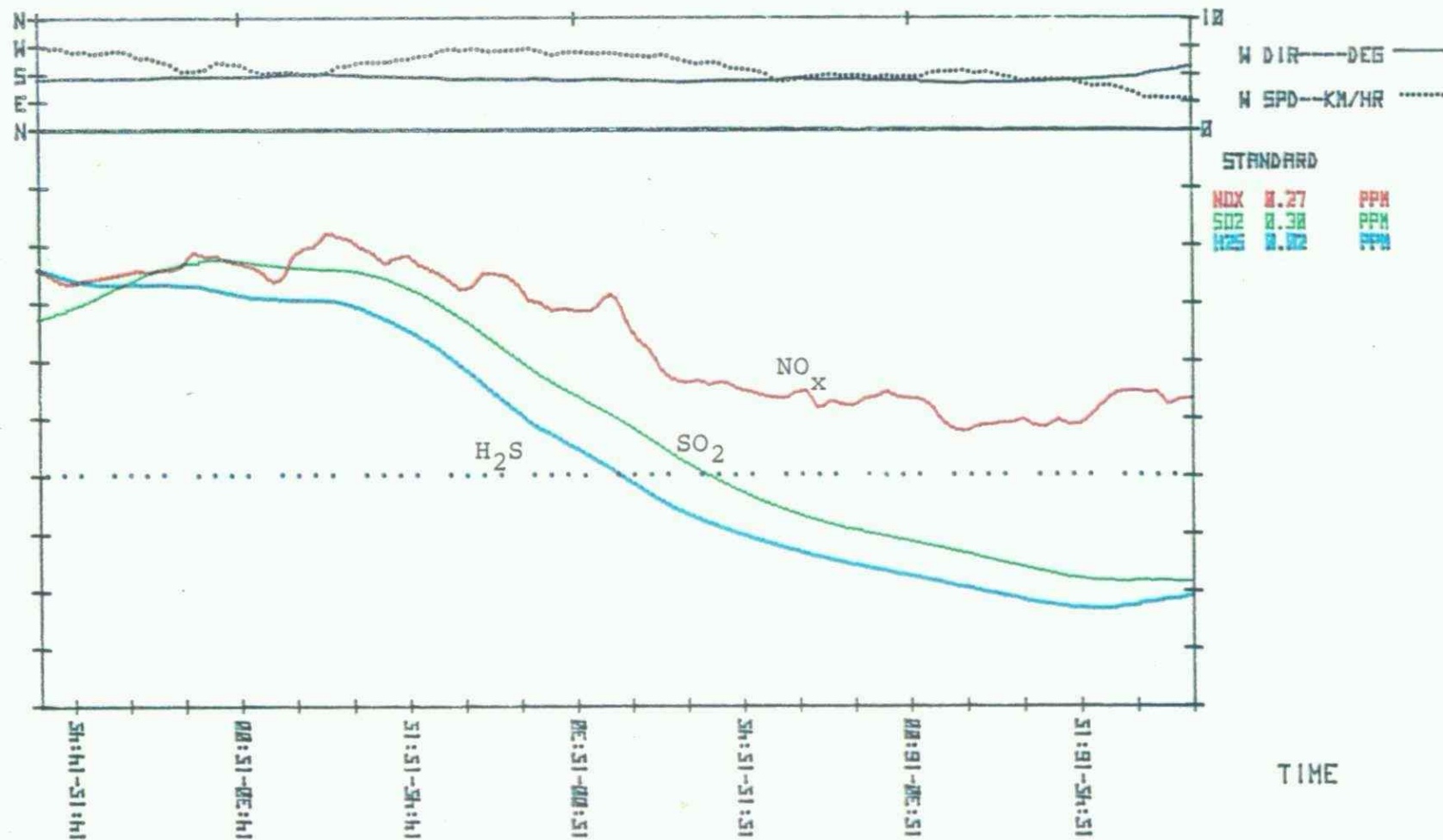


Figure #12

MARATHON #5

16:31 AUG 31 1978

SCAN= 150 SEC

AVE= 30 MIN

3.2KM W OF OPP STATION ON HWY#17 (X4410-Y0230); 6.2KM @ 355 DEG/SRC

0.000
0
0
0

0.007
16
78
987

0.004
15
92
987

0.002
13
100
986

0.000
0
0
0

SRAD W/CH2
TEMP DEG C
HUM % REL
PRES MBAR

NOX
SO2
H2S

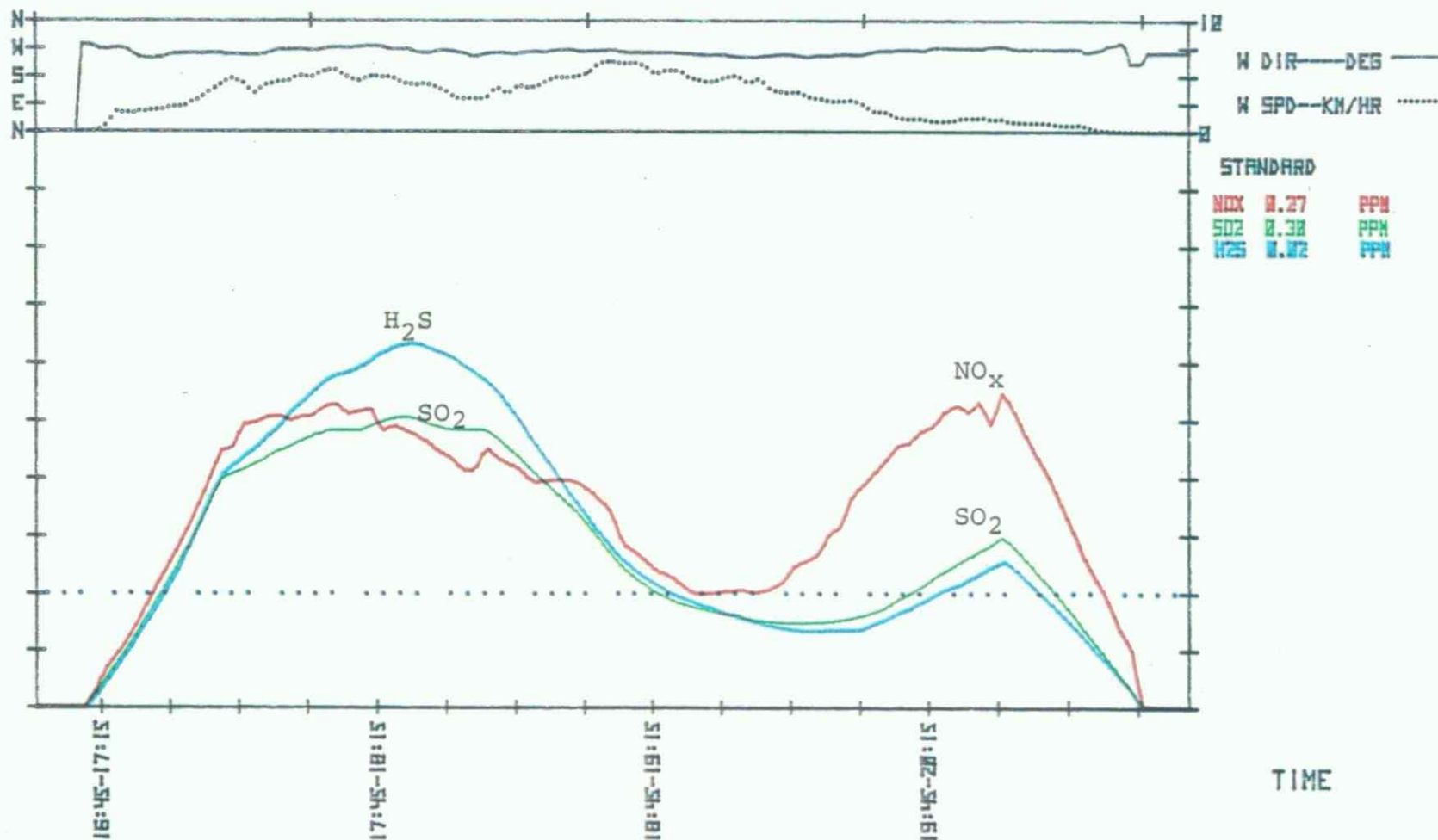


Figure #13

TERRACE BAY #3

19:39 SEP 1 1978

SCAN= 50

SEC

AVE= 30

MIN

ADJACENT TO CLARIFIER & SETTLING POND(X9253-Y0510): 1.1KM @ 0.5005/SEC

0.000	0.000	0.000	0.000	0.000	0.000	0.001	SRAD	W/CM2
15	16	16	16	16	17	16	TEMP	DEG C
100	100	100	100	100	100	100	HUM	% REL
975	975	974	974	973	973	973	PRES	MBAR

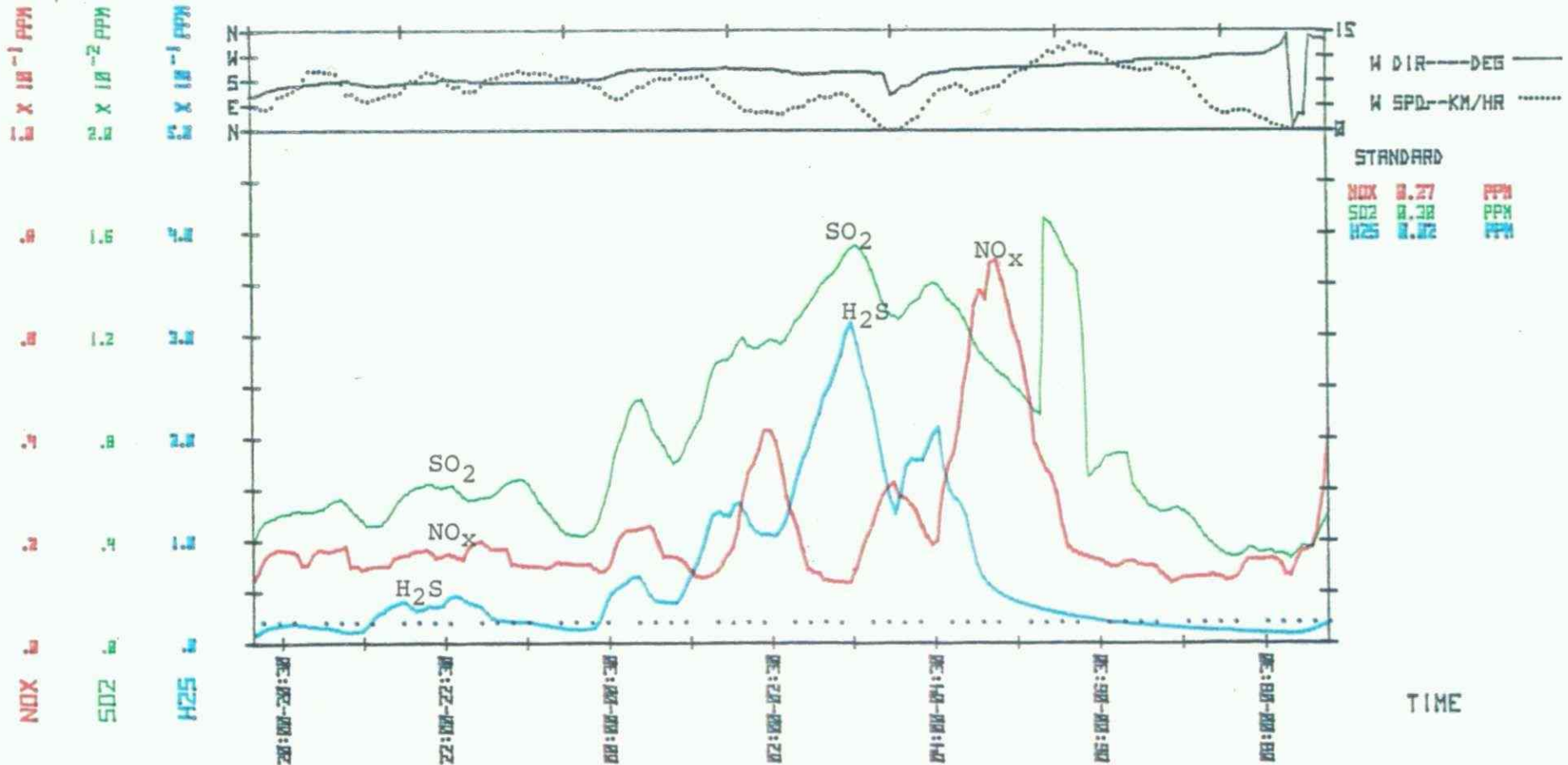


Figure #14

TERRACE BAY #2

16:06 AUG 30 1978

SCAN= 150 SEC

AVE= 30 MIN

FIRST EFFLUENT CROSSING (X9390-Y0660): 2.5KM @ 050055/SEC

0.056	0.043	0.020	0.002	0.000	0.000	0.000	5880	W/CH2
13	14	NS	11	9	7	6	TEMP	DEG C
84	94	99	100	100	100	100	HUM	% REL
986	986	986	986	986	987	987	PRES	MBAR

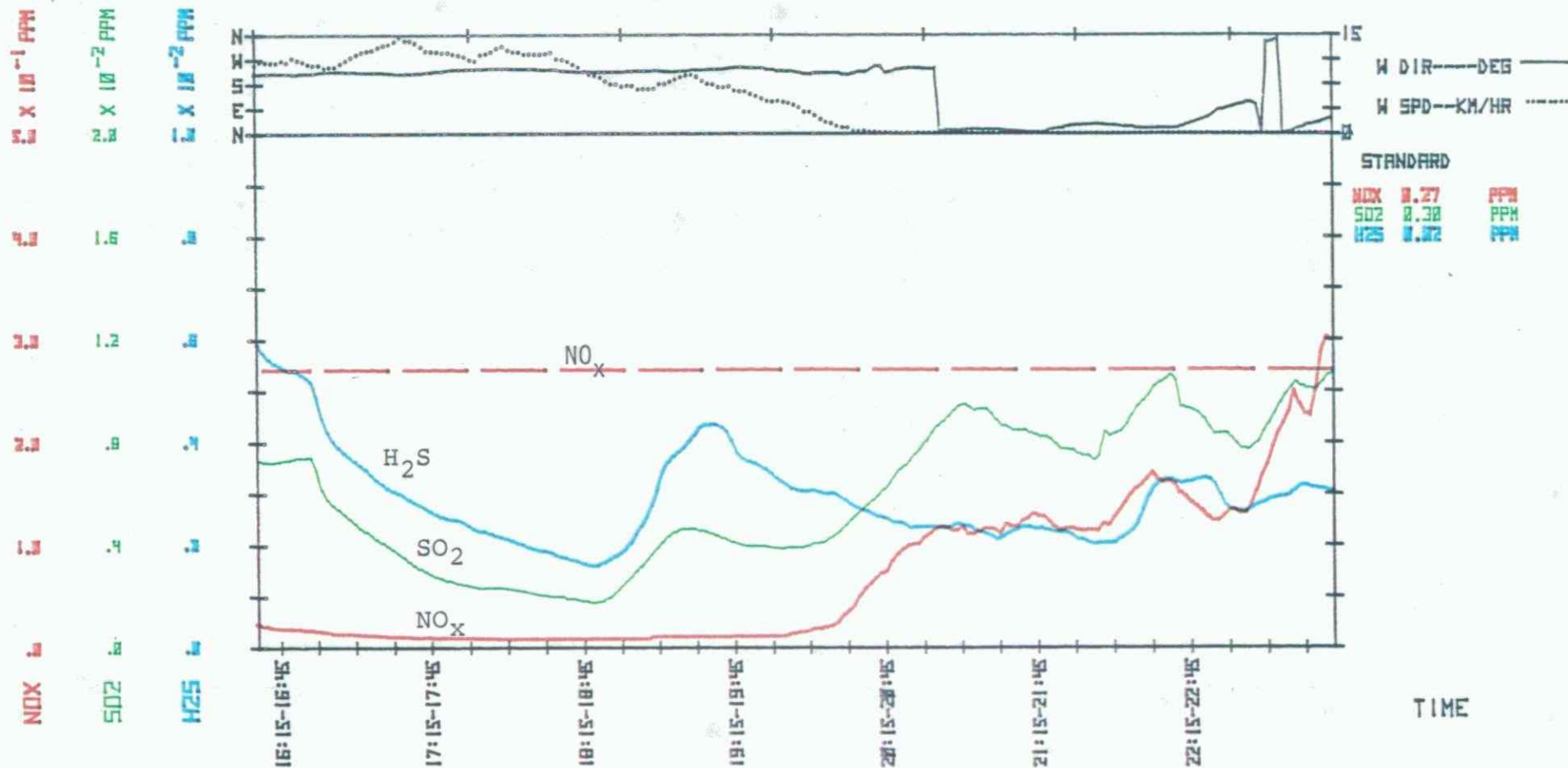


Figure #15

SO2 VS H2S

SURVEY: THUNDER BAY #53
 START TIME: 17:45 SEP 3 1978
 SCAN TIME: 150 SEC
 LOCATION: MONTREAL & NEEBING STS. (X2928-Y5838); 1.0KM & 0.05 DEG/SEC

DURATION: 15.1 HRS
 AVERAGING TIME: 15 MIN
 Y DELAY: 0 MIN

NO POINTS= 68
 COR COEFF= 0.63983

H2S
 MEAN = 0.0024
 ST DEV= 0.0031

SO2
 MEAN = 0.0109
 ST DEV= 0.0255

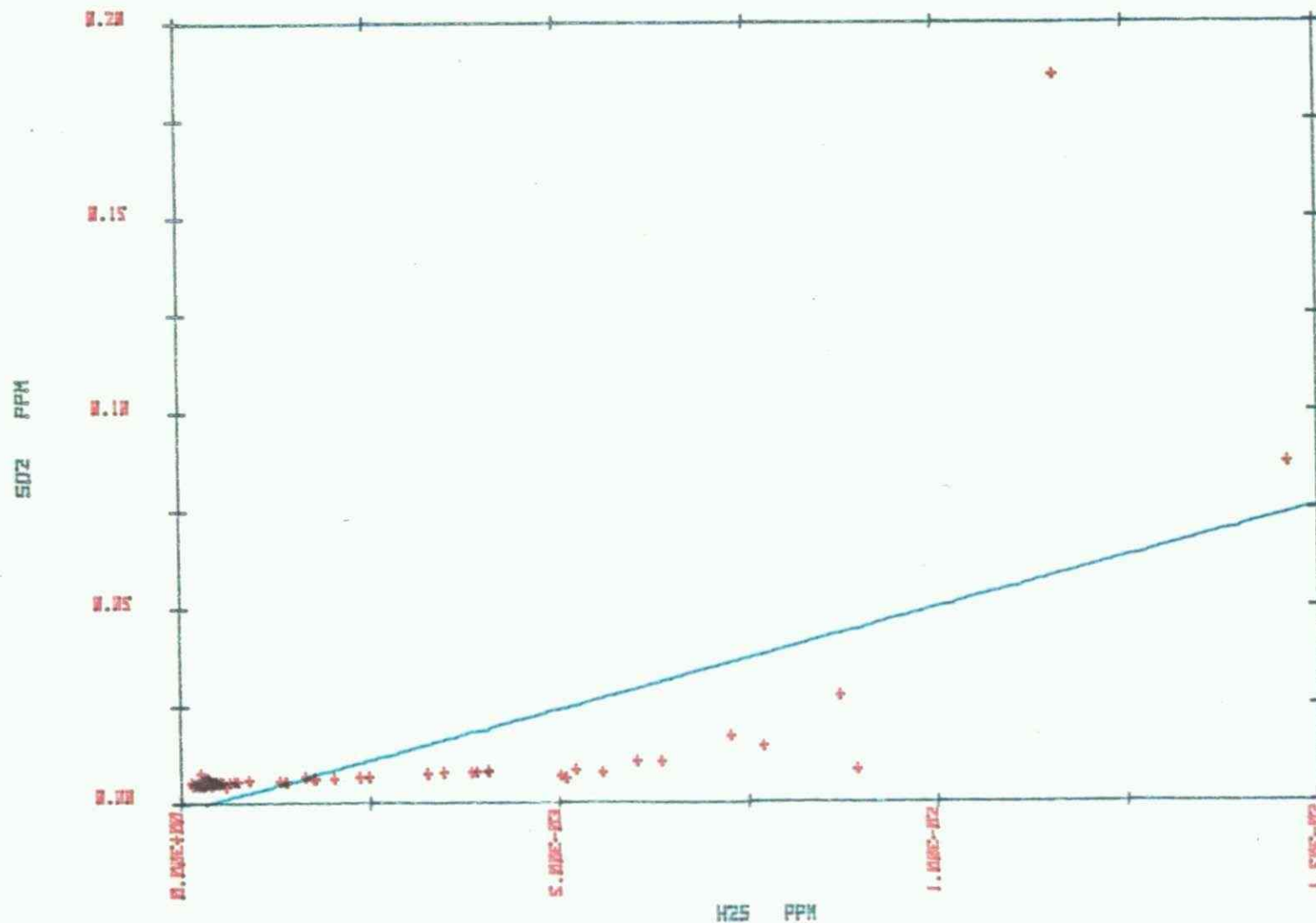


Figure #16

NO2 VS H2S

SURVEY: THUNDER BAY #53
 START TIME: 17:45 SEP 3 1978
 SCAN TIME: 150 SEC
 LOCATION: MONTREAL & NEEDING STS. (X2528-Y5838) 1.20KM & 0.05 DEG/SEC

DURATION: 15.1 HRS
 AVERAGING TIME: 30 MIN
 Y DELAY: 0 MIN

NO POINTS= 30
 COR COEFF=-0.34647

H2S
 MEAN = 0.0024
 ST DEV= 0.0031

NO2
 MEAN = 0.0194
 ST DEV= 0.0062

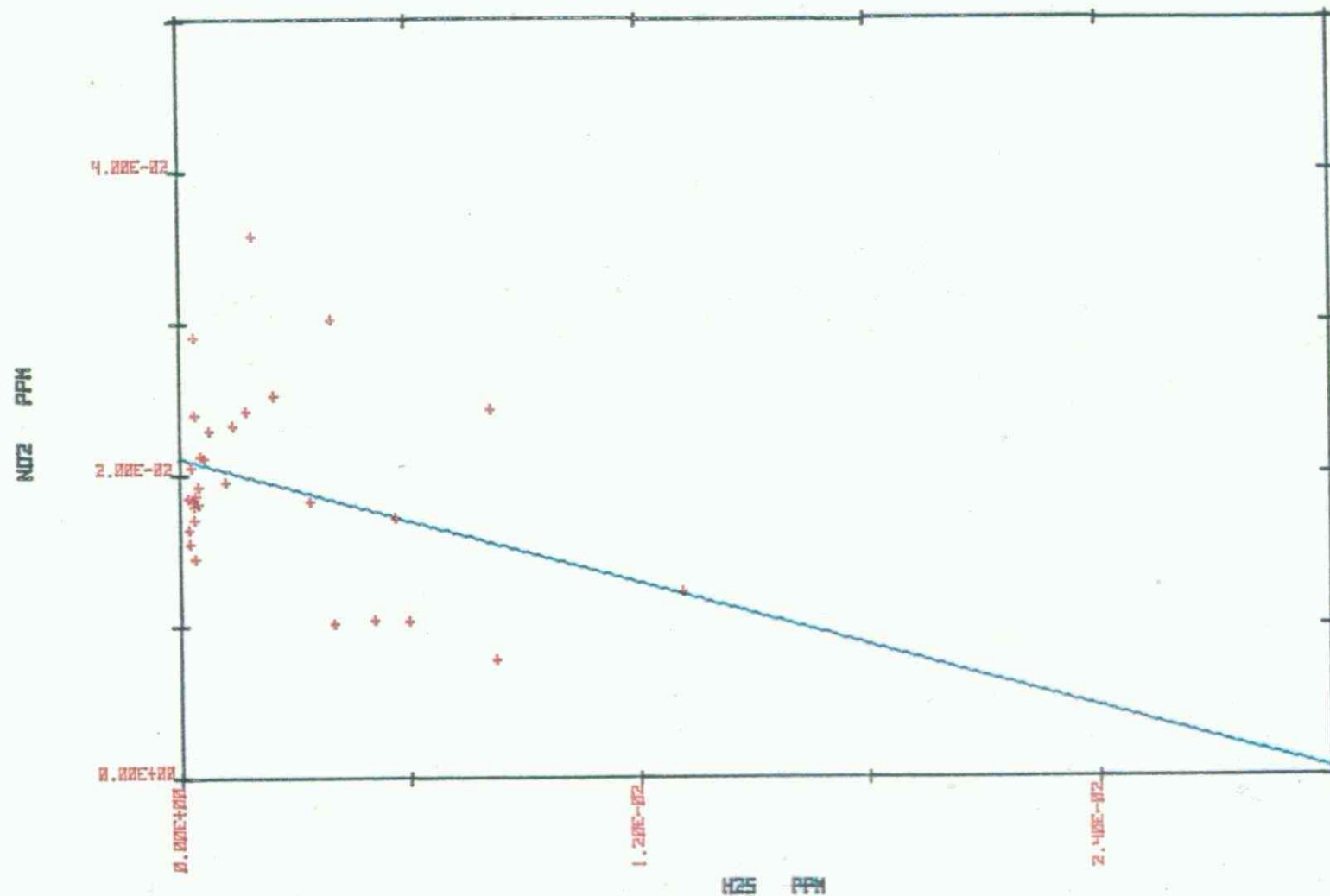


Figure #17

SO2 VS H2S

SURVEY: MARATHON #4
 START TIME: 17:02 AUG 29 1978
 SCAN TIME: 128 SEC
 LOCATION: WATER TOWER IN DOWNTOWN MARATHON (X4545-Y9615); 1.0KM & 290 DEG/SEC

DURATION: 16.9 HRS
 AVERAGING TIME: 15 MIN
 Y DELAY: 0 MIN

NO POINTS= 47
 COR COEFF= 0.89727

H2S
 MEAN = 0.0111
 ST DEV= 0.0158

SO2
 MEAN = 0.0133
 ST DEV= 0.0127

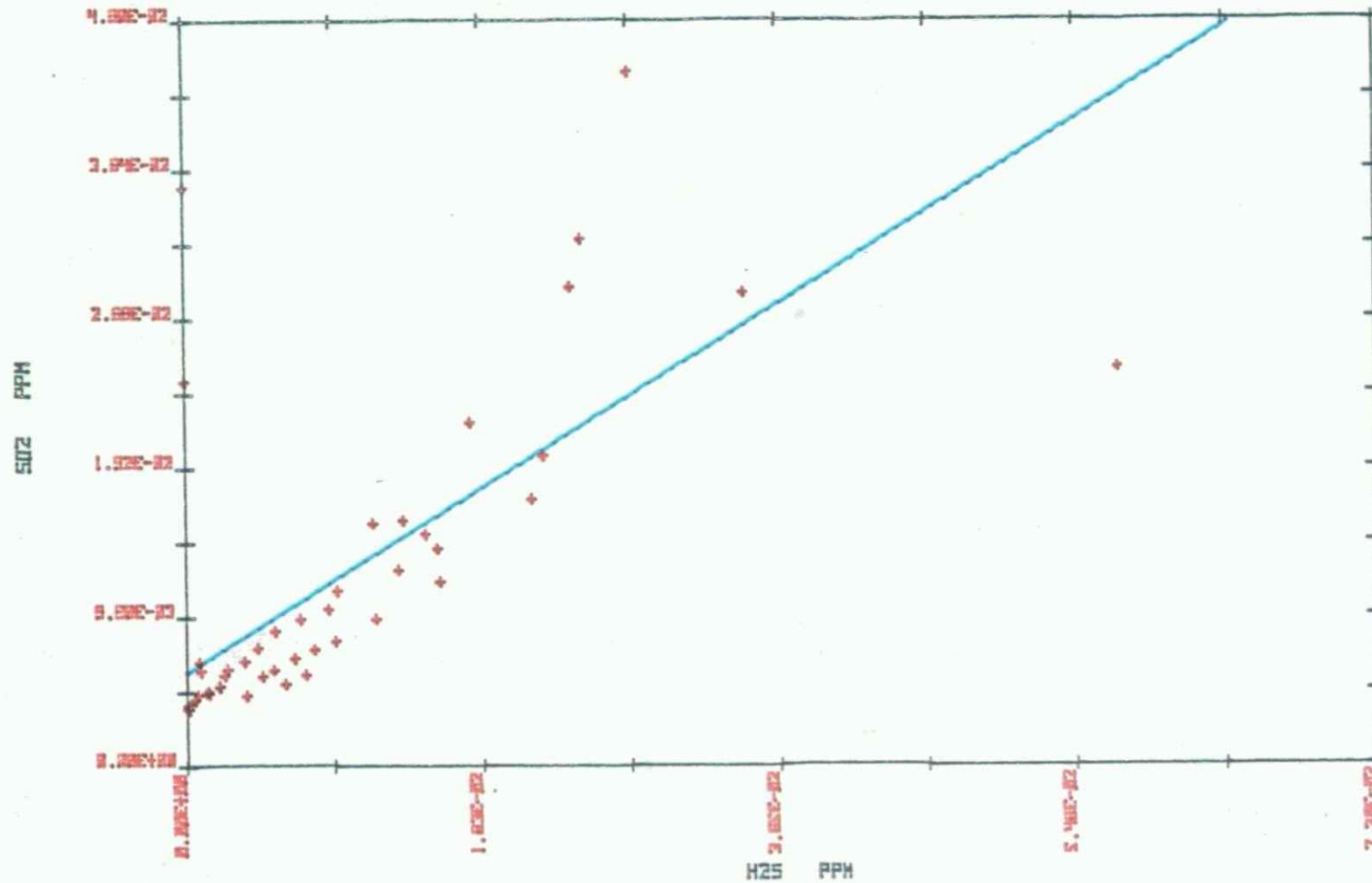


Figure #18

SURVEY: MARATHON #6 DURATION: 6.6 HRS
START TIME: 21:22 AUG 31 1978 AVERAGING TIME: 5 MIN
SCAN TIME: 152 SEC Y DELAY: 0 MIN
LOCATION: OPP STATION ON HWY #17 (X4700-Y0100); 5.5KM @ 025 DEG/SEC



NO2 VS H2S

SURVEY: MARATHON #4
 START TIME: 17:02 AUG 29 1978
 SCAN TIME: 120 SEC
 LOCATION: WATER TOWER IN DOWNTOWN MARATHON (X4545-Y9615); 1.0KM & 200 DEG/SEC

DURATION: 16.9 HRS
 AVERAGING TIME: 30 MIN
 Y DELAY: 0 MIN

NO POINTS= 22
 COR COEFF= 0.87113

H2S
 MEAN = 0.0111
 ST DEV= 0.0158

NO2
 MEAN = 0.0158
 ST DEV= 0.0147

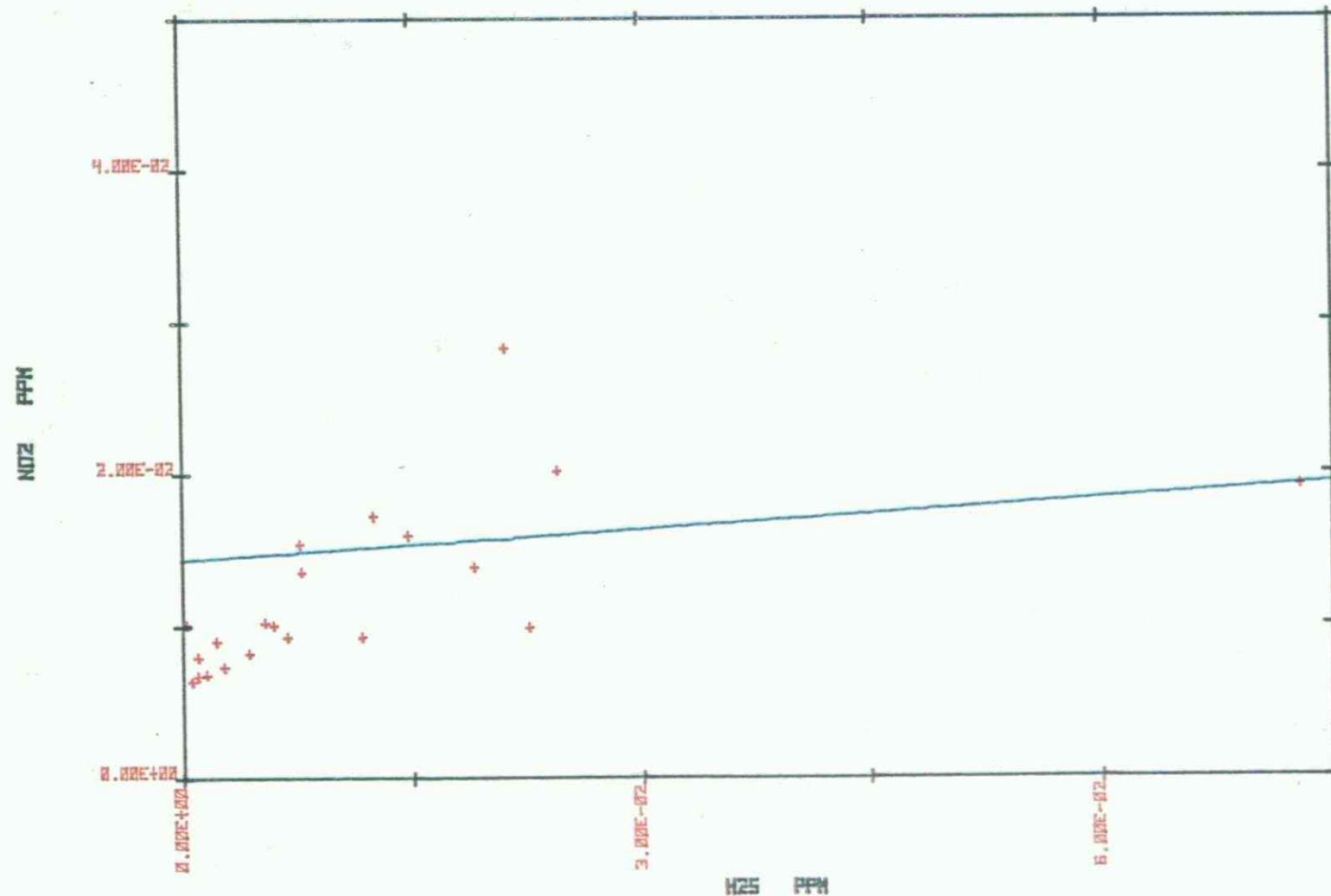


Figure #20

SURVEY: TERRACE BAY #1 DURATION: 17.5 HRS
START TIME: 15:27 AUG 28 1978 AVERAGING TIME: 15 MIN
SCAN TIME: 90 SEC Y DELAY: 0 MIN
LOCATION: MOOSE LODGE, OFF HILL RD. (X9300-Y0400); 1.1KM @ 130 DSS/SEC

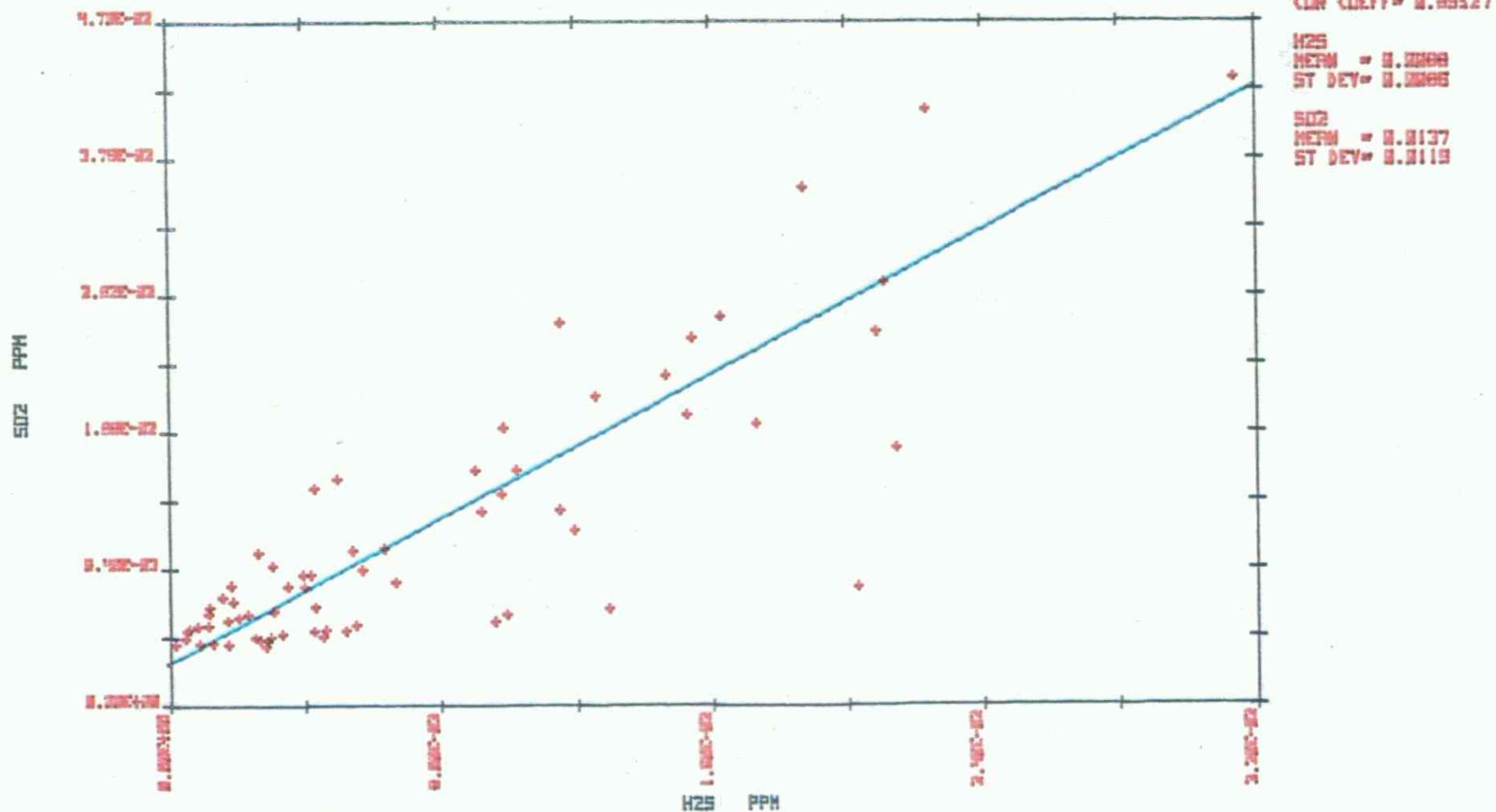
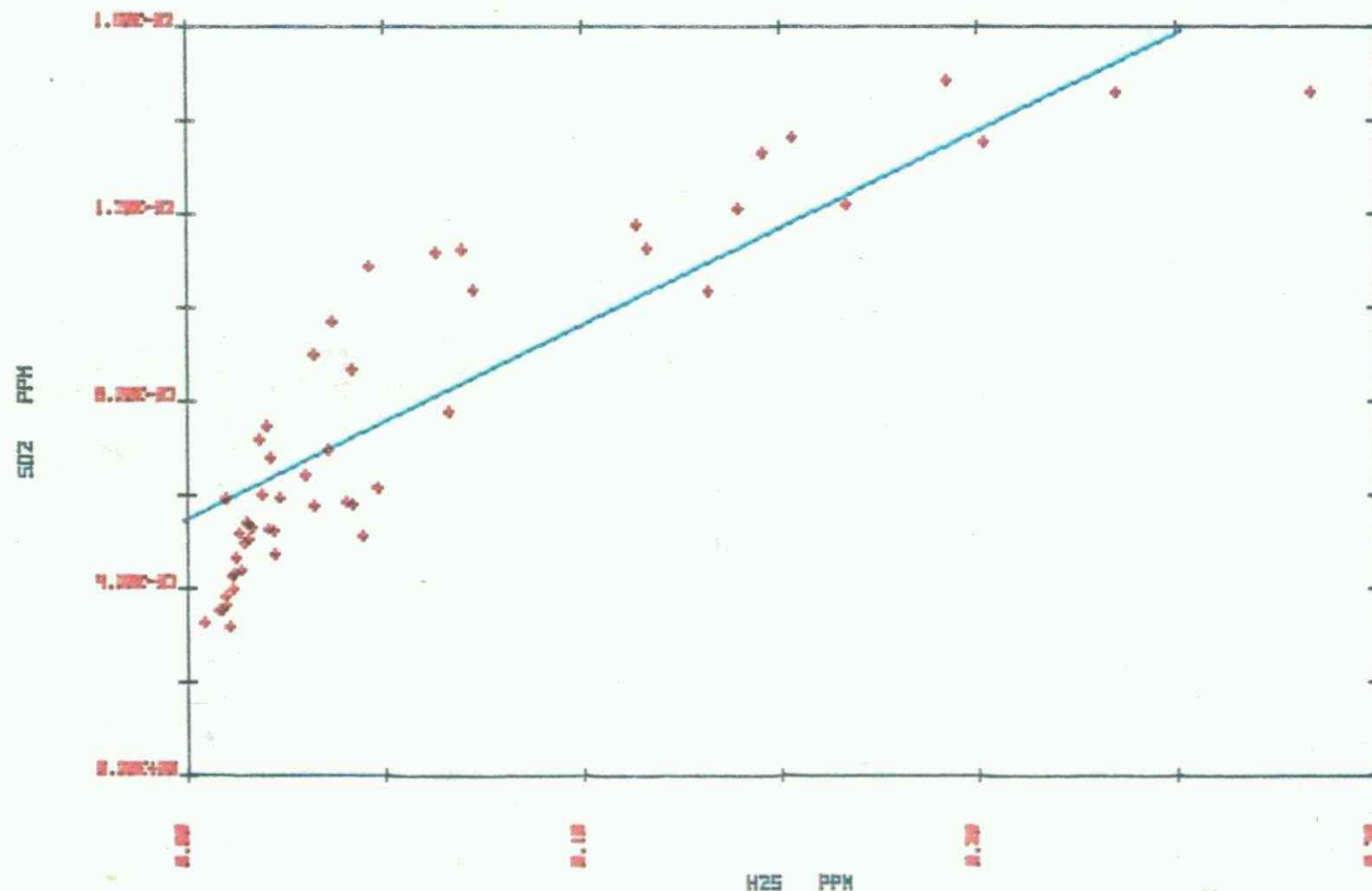


Figure #21

S02 VS H2S

SURVEY: TERRACE BAY #3
 START TIME: 19:39 SEP 1 1978
 SCAN TIME: 98 SEC
 LOCATION: ADJACENT TO CLARIFIER & SETTLING POND(X9255-Y0510); 1.1KM @ 250DEG/SRC
 DURATION: 13.6 HRS
 AVERAGING TIME: 15 MIN
 Y DELAY: 0 MIN



NO POINTS= 54
 COR COEFF= 0.72585

H2S
 MEAN = 0.8614
 ST DEV= 0.8739

S02
 MEAN = 0.0088
 ST DEV= 0.0042

Figure #22

THUNDER BAY #16

18:01 AUG 7 1978

LENGTH= 2.6 HRS

DELAY= 0 MIN

LOC: PLANT SIGN (X2910-Y5810); 0.7KM & 355 DGS/SRC

PREVAILING WINDS, BLOWING TOWARDS:

$$1 \text{ DIV} = 10 \text{ } \times$$

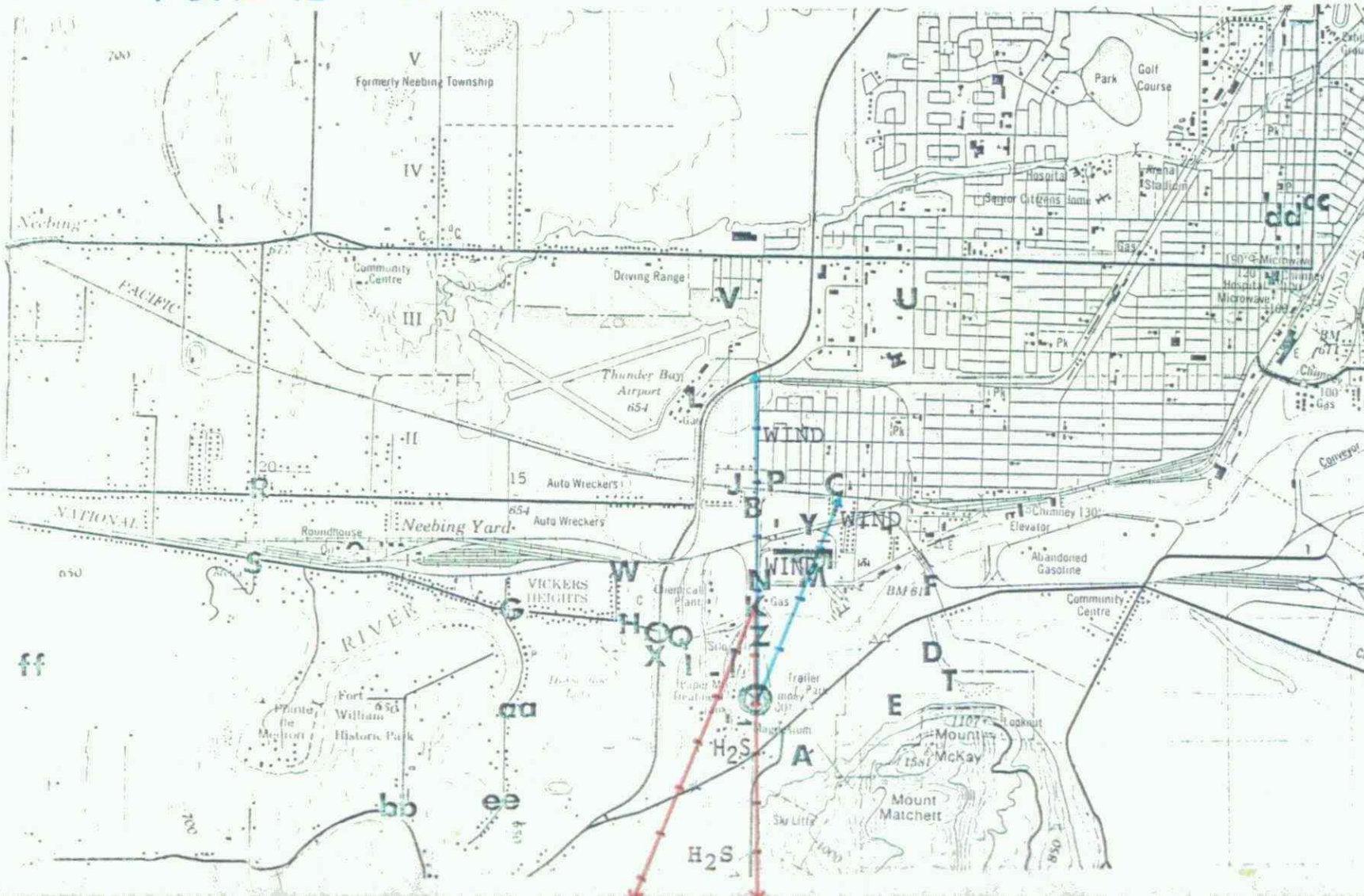
SCAN= 60 SEC AVE= 30 MIN

MINIMUM MEAN= 1.000000E-03 PPM

WIND RANGE= 0 / 20 KM/HR

ARITHMETIC MEAN: H25

$$|DIV| = 0.01 \text{ PPM}$$



Reference
Point - 



Map #10

-72-

Scale — km



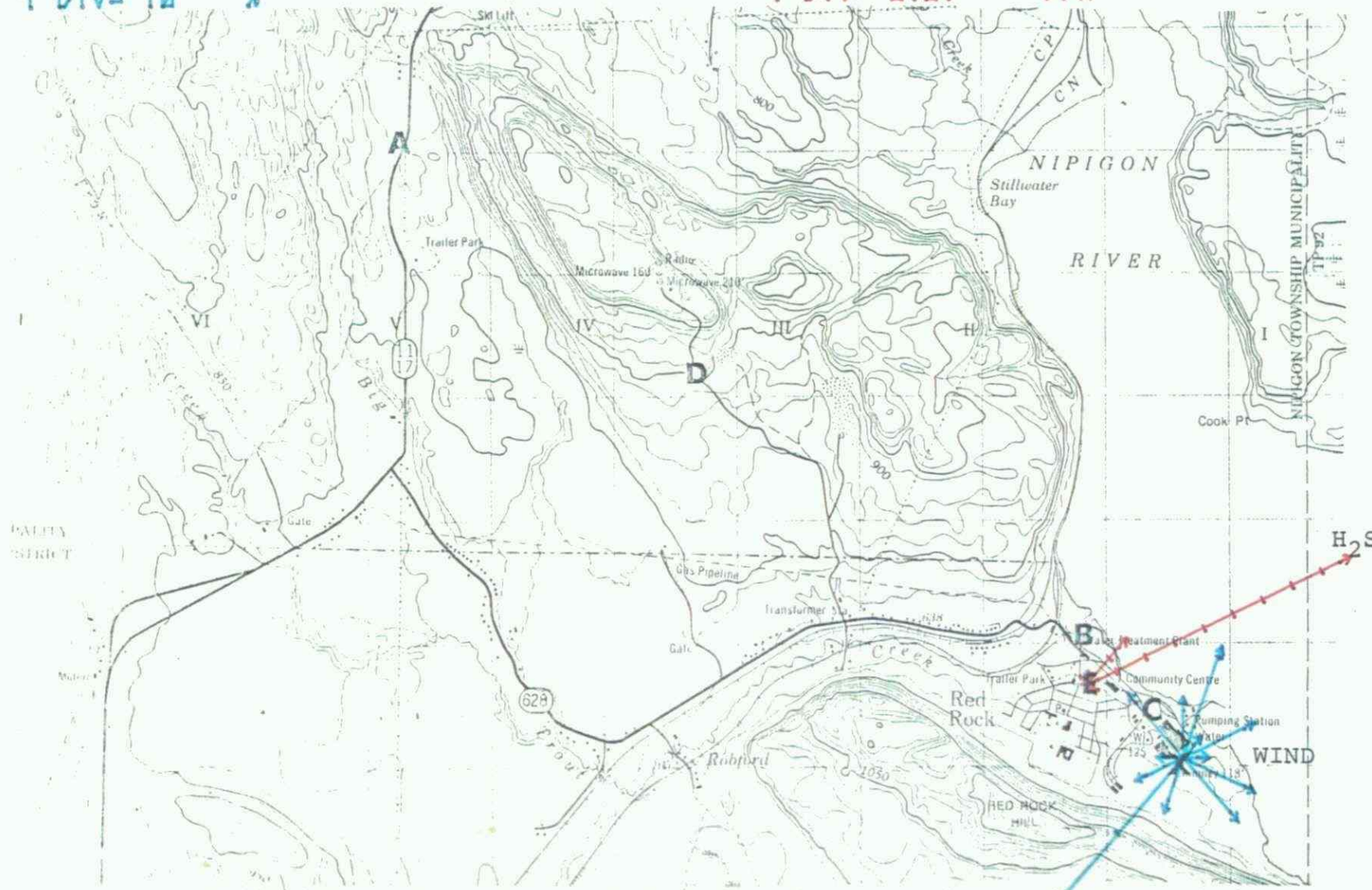
RED ROCK #5

16:12 AUG 27 1978
 LENGTH= 18 HRS
 DELAY= 0 MIN
 LOC: RED ROCK INN (X0785-Y2165); 1KM & 310 DGS/SRC

SCAN= 150 SEC AVE= 30 MIN
 MINIMUM MEAN= 1.00000E-06 PPM
 WIND RANGE= 0 / 20 KM/HR

PREVAILING WINDS; BLOWING TOWARDS:
 1 DIV= 10 %

ARITHMETIC MEAN: H2S
 1 DIV= 0.01 PPM



Reference
 Point - X
 Map #11

-73-



Scale
 0 2 km

RED ROCK #3

11:27 AUG 27 1978

LENGTH= 1.4 HRS

DELAY= 0 MIN

LOC: 0.1KM E OF FENCE, 0.1KM SE OF ESSO (X0835-Y2150); 0.5KM & 340 DGS/SRC

SCAN= 30 SEC AVE= 30 MIN

MINIMUM MEAN= 1.00000E-03 PPM

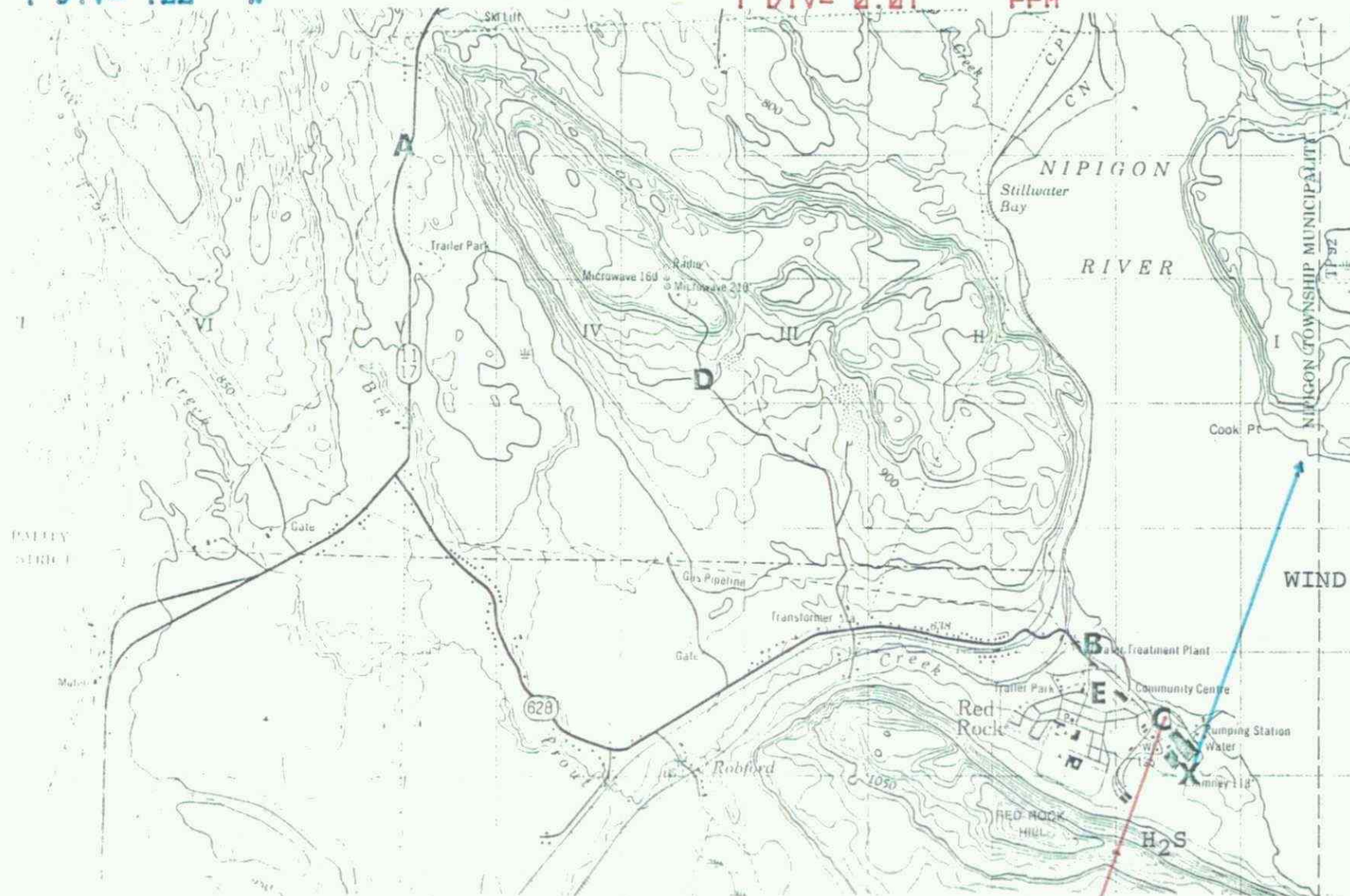
WIND RANGE= 0 / 20 KM/HR

ARITHMETIC MEAN: H2S

1 DIV= 0.01 PPM

PREVAILING WINDS; BLOWING TOWARDS:

1 DIV= 100 %



Reference
Point - X

Map #12



Scale

0 2 km

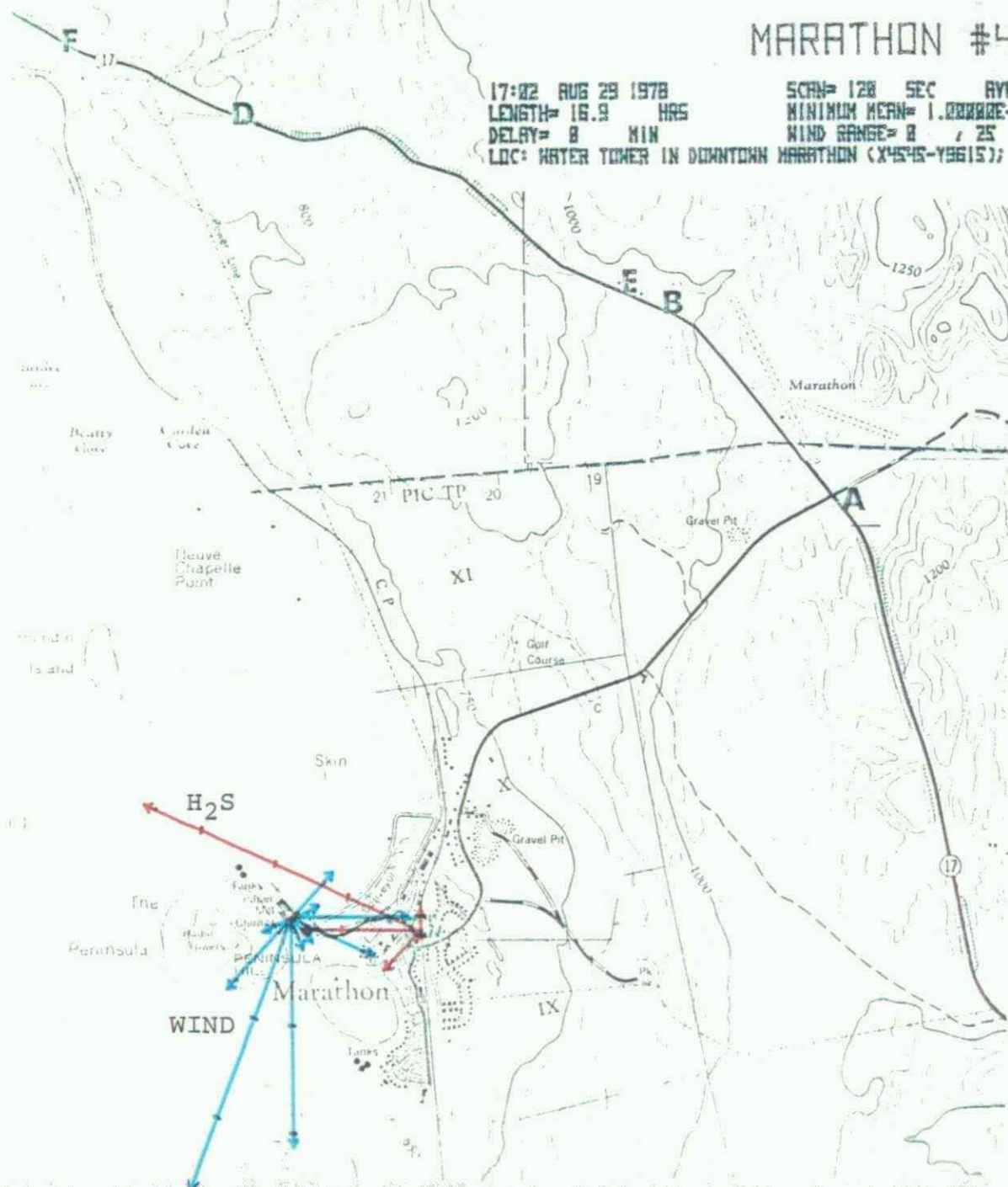
MARATHON #4

17:02 AUG 29 1978
LENGTH= 16.9 HRS
DELAY= 8 MIN

SCAN= 128 SEC AVE= 38 MIN
MINIMUM MEAN= 1.00000E-06 PPM
WIND RANGE= 0 , 25 KM/HR
LOC: WATER TOWER IN DOWNTOWN MARATHON (X4545-Y9615); 1.0KM & 898 DEG/SRC

ARITHMETIC MEAN: H2S
1 DIV= 0.01 PPM

PREVAILING WINDS; BLOWING TOWARDS:
1 DIV= 10 %



Reference
Point - X

Scale
0 2 km

MARATHON #6

21:22 AUG 31 1978

LENGTH= 6.6 HRS

DELAY= 0 MIN

LOC: OPP STATION ON HWY #17 (X4700-YA100); 5.5KM & 025 DEG/SEC

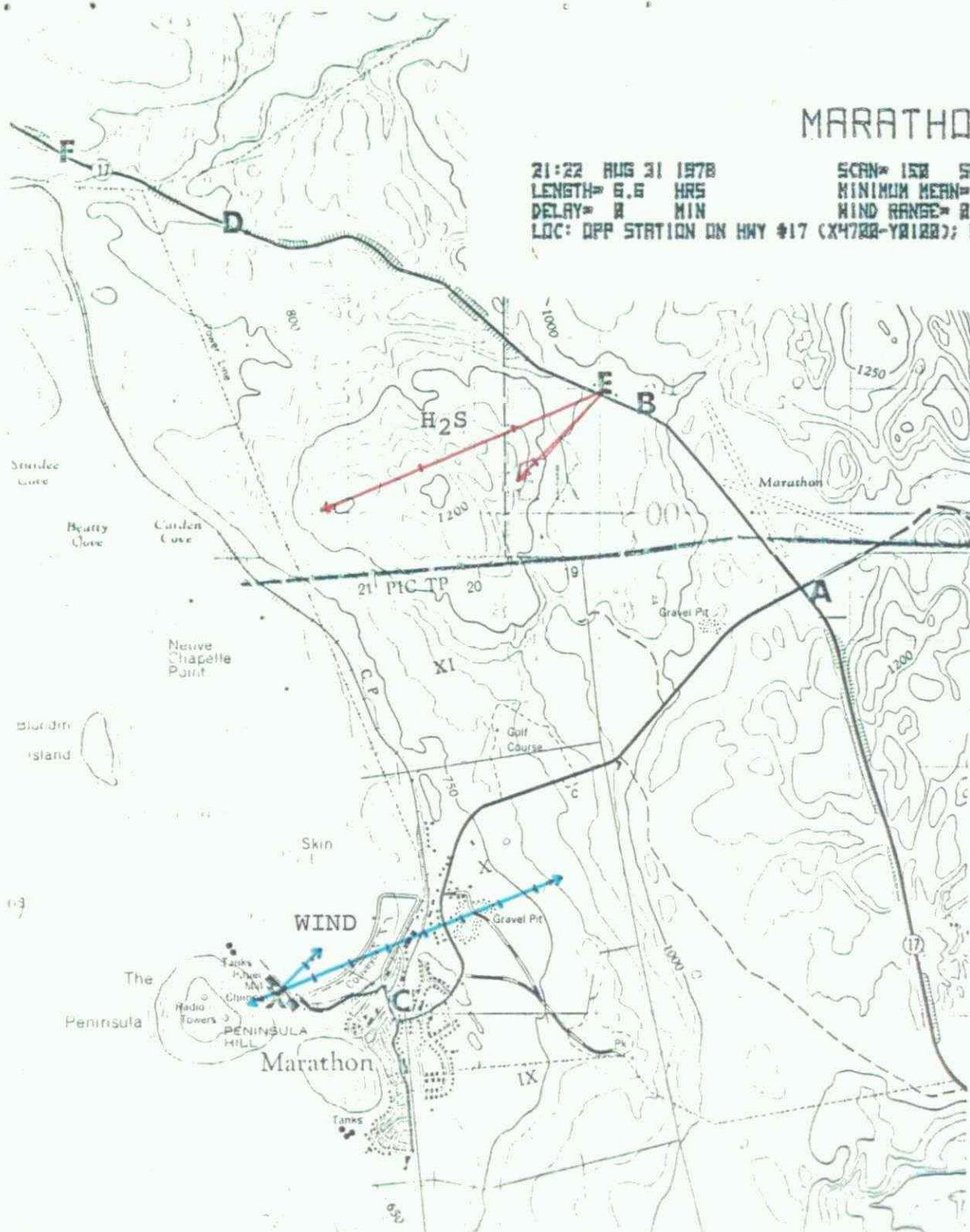
SCAN= 150 SEC AVE= 30 MIN

MINIMUM MEAN= 1.00000E-03 PPM

WIND RANGE= 0 / 15 KM/HR

PREVAILING WINDS; BLOWING TOWARDS:
1 DIV= 10 X

ARITHMETIC MEAN: H2S
1 DIV= 0.01 PPM



Reference
Point - X

Scale

0 2 km

Map #14

TERRACE BAY #3

19:39 SEP 1 1978
 LENGTH= 13.6 HRS
 DELAY= 0 MIN

SCAN= 90 SEC AVE= 30 MIN
 MINIMUM MEAN= 1.00000E-03 PPM
 WIND RANGE= 0 / 15 KM/HR

LOC: ADJACENT TO CLARIFIER & SETTLING POND(X9255-Y0510); 1.1KM & 050DEG/SRC

PREVAILING WINDS; BLOWING TOWARDS:

1 DIV= 10 X

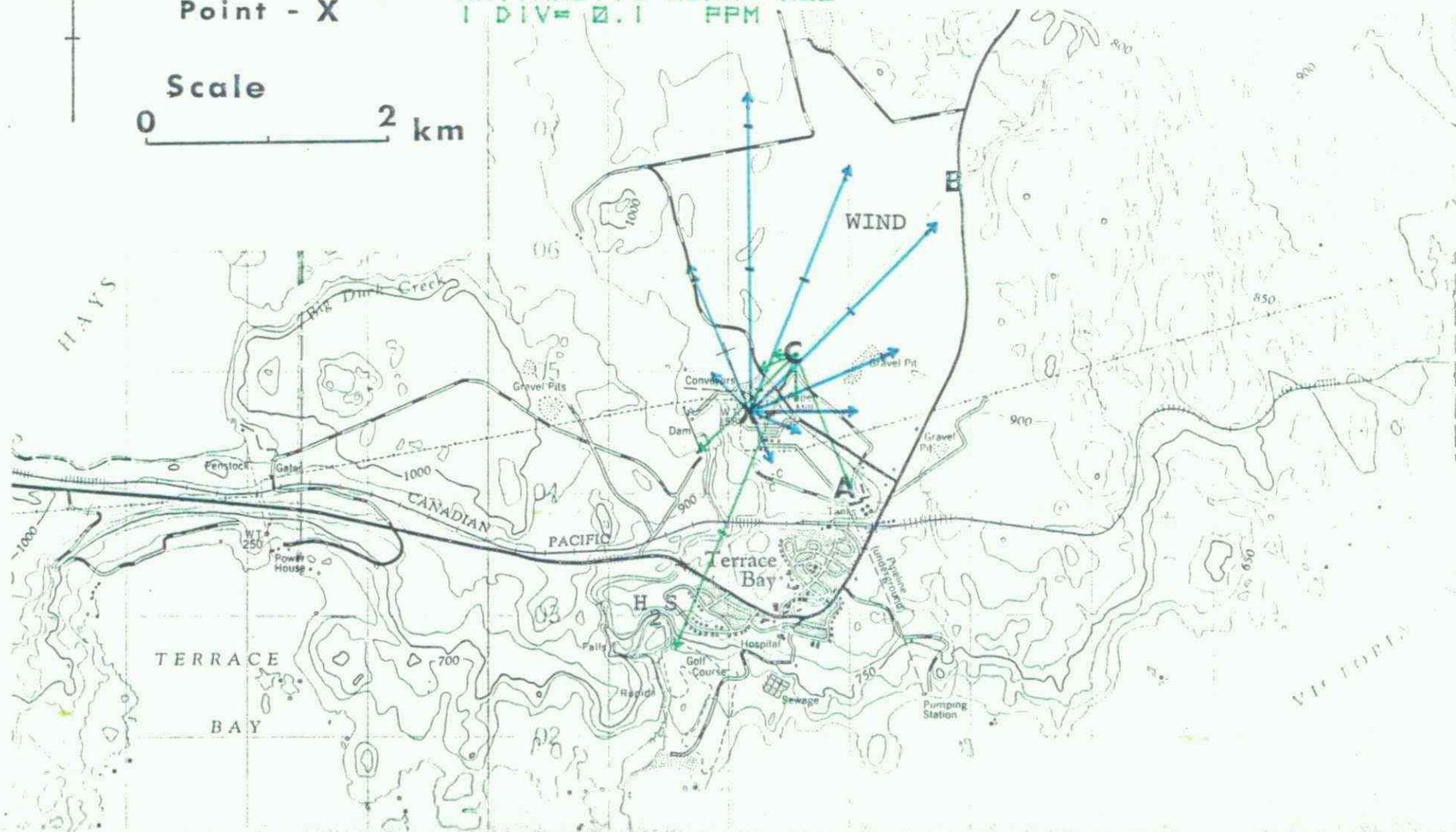
ARITHMETIC MEAN: H25

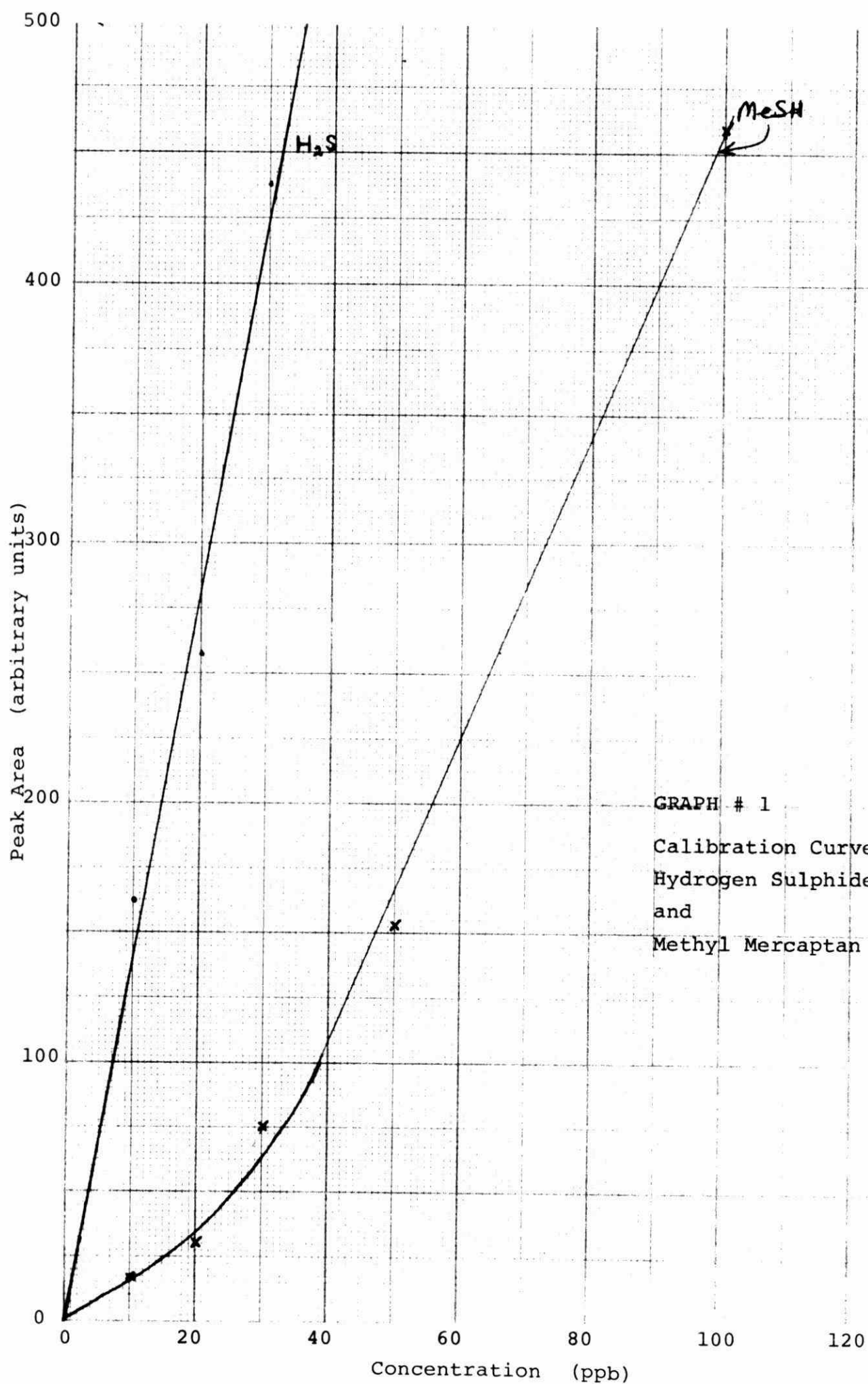
1 DIV= 0.1 PPM

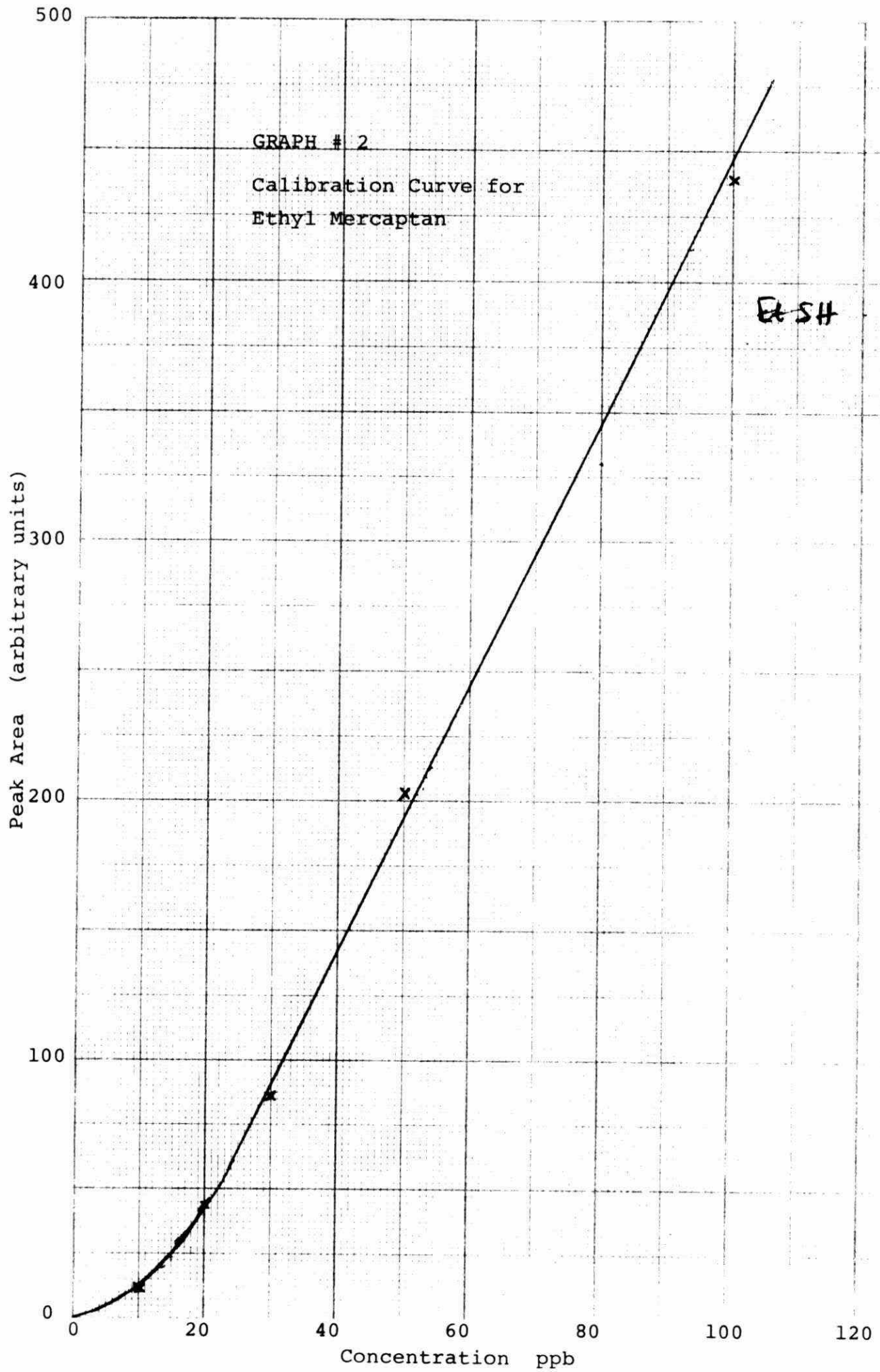
Reference
 Point - X

Scale

0 2 km







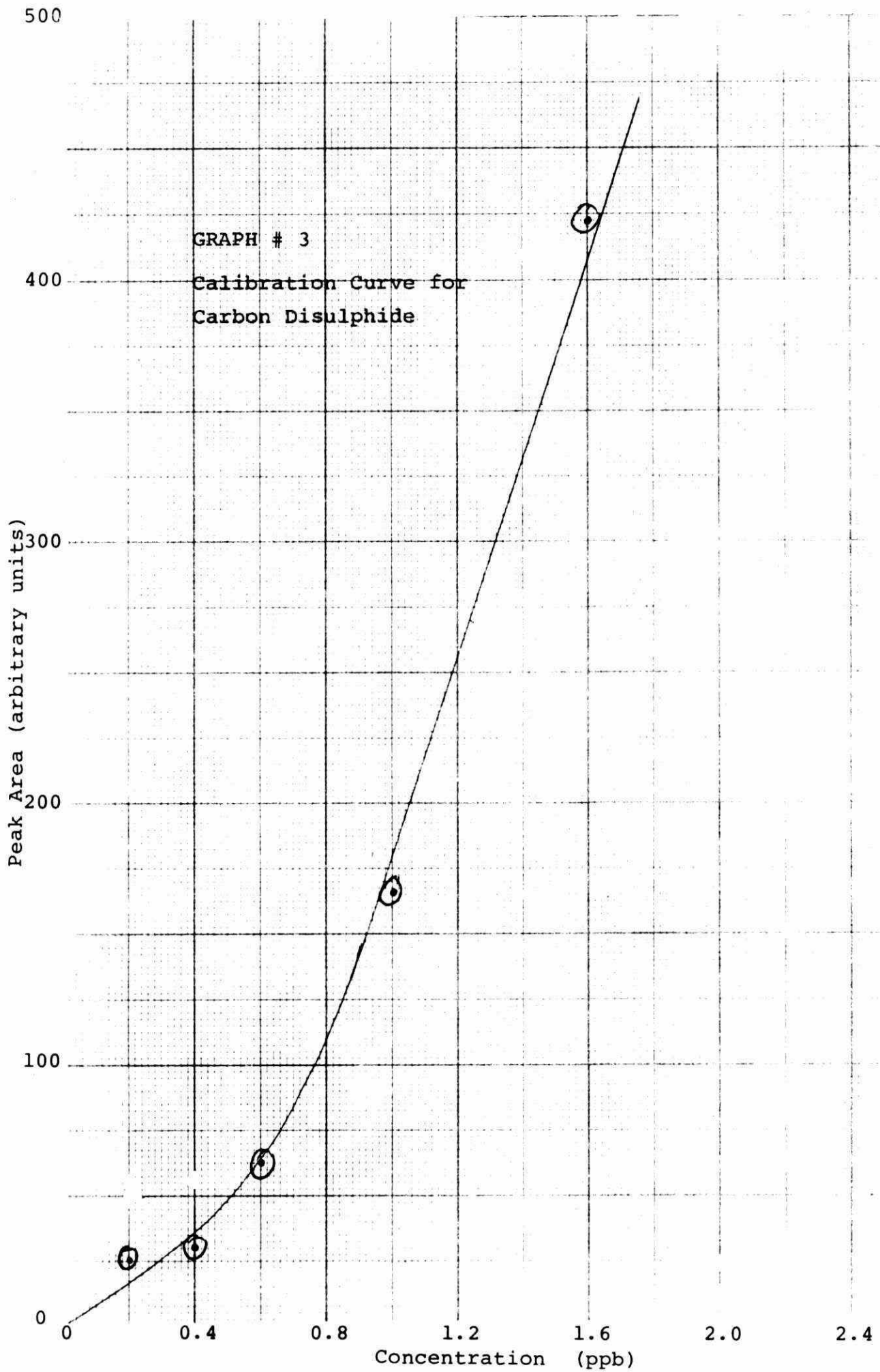


TABLE # 7a

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			H ₂ S		SO ₂		H ₂ S	SO ₂	H ₂ S	SO ₂	
			Min.	Max.	Min.	Max.					Min.
Thunder Bay #1	July 31	16:27 - 07:12	0.001	0.026	0.001	0.013	0.005	0.005	0.002	0.001	1
#2	Aug. 1	14:40 - 16:40	0.004	0.012	0.001	0.004	0.008	0.002	0.006	0.001	1.5
#3	1	18:09 - 08:54	0.001	0.024	0.001	0.029	0.014	0.016	0.003	0.003	1.5
#4	2	16:09 - 21:54	0.001	0.014	0.006	0.010	0.007	0.008	0.002	0.008	2.5
#5	2	21:58 - 08:58	0.001	0.003	0.005	0.092	0.002	0.044	0.001	0.012	2.5
#6	3	12:51 - 15:21	0.001	0.009	0.001	0.008	0.006	0.006	0.002	0.005	2.5
#7	3	16:28 - 21:58	0.001	0.003	0.001	0.171	0.001	0.062	0.001	0.013	1.5
#8	3	22:32 - 11:47	0.001	0.021	0.001	0.050	0.017	0.029	0.007	0.006	1.5
#9	4	16:52 - 06:52	0.001	0.009	0.001	0.240	0.003	0.10	0.001	0.014	2.5
#10	5	15:52 - 22:07	0.001	0.009	0.002	0.013	0.005	0.009	0.001	0.005	2.5
#11	5	22:45 - 00:30	0.001	0.001	0.003	0.010	0.001	0.008	0.001	0.007	2.5
#12	6	00:42 - 08:42	0.001	0.001	0.002	0.012	0.001	0.009	0.001	0.006	2.5
#14	6	21:03 - 09:03	0.001	0.001	0.002	0.011	0.001	0.009	0.001	0.007	2.5

TABLE # 7a (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE August 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			H ₂ S		SO ₂		H ₂ S	SO ₂	H ₂ S	SO ₂	
			Min.	Max.	Min.	Max.					Min.
Thunder Bay #15	7	15:35 - 17:35	0.011	0.058	0.004	0.020	0.043	0.017	0.032	0.012	1
#16	7	18:01 - 20:31	0.040	0.085	0.019	0.044	0.070	0.037	0.063	0.029	1
#17	10	14:42 - 16:42	0.002	0.022	0.006	0.010	0.014	0.009	0.006	0.007	2.5
#18	10	17:34 - 21:34	0.007	0.101	0.007	0.239	0.060	0.049	0.033	0.016	1
#19	10	22:33 - 09:03	0.001	0.005	0.002	0.014	0.003	0.009	0.001	0.006	2.5
#20	11	12:44 - 17:34	0.004	0.028	0.001	0.009	0.019	0.007	0.009	0.004	2.5
#21	11	17:58 - 09:13	0.001	0.005	0.001	0.004	0.005	0.003	0.001	0.001	2.5
#22	12	15:10 - 22:10	0.002	0.022	-	-	0.015	-	0.007	-	1
#23	12	22:14 - 08:59	0.001	0.009	-	-	0.006	-	0.001	-	2.5
#24	13	14:52 - 17:37	0.001	0.031	0.001	0.138	0.019	0.017	0.013	0.005	1
#25	13	19:12 - 08:57	0.001	0.002	0.001	0.006	0.001	0.005	0.001	0.001	2.5
#26	14	10:56 - 13:11	0.006	0.032	0.005	0.011	0.021	0.009	0.014	0.007	2.5
#27	14	13:38 - 15:38	0.006	0.016	0.009	0.031	0.012	0.016	0.009	0.012	1

TABLE # 7a (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE August 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			H ₂ S		SO ₂		H ₂ S	SO ₂	H ₂ S	SO ₂	Min.
			Min.	Max.	Min.	Max.					
Thunder Bay #28	14	16:01 - 17:01	0.007	0.021	0.007	0.014	0.010	0.010	0.010	0.010	1
#30	17	17:54 - 18:49	0.009	0.036	0.001	0.004	0.027	0.003	0.020	0.002	1
#31	17	19:17 - 22:27	0.001	0.005	0.001	0.016	0.004	0.002	0.001	0.001	2
#32	17	22:49 - 08:49	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.001	2
#33	18	21:31 - 09:46	0.001	0.008	0.001	0.001	0.004	0.001	0.001	0.001	2.5
#34	19	17:16 - 21:46	0.002	0.017	0.001	0.012	0.012	0.003	0.008	0.002	2.5
#35	19	21:53 - 09:08	0.001	0.006	0.001	0.013	0.004	0.002	0.001	0.001	2.5
#37	20	22:04 - 09:04	0.001	0.037	0.001	0.011	0.001	0.008	0.001	0.004	1.5
#38	21	14:54 - 15:39	0.003	0.012	0.002	0.010	0.008	0.006	0.006	0.005	1.5
#39	21	16:29 - 23:14	0.001	0.038	0.003	0.279	0.025	0.069	0.013	0.011	2.5
#40	21	23:30 - 00:15	0.002	0.006	0.003	0.006	0.003	0.005	0.001	0.004	1.5
#41	22	10:49 - 15:19	0.001	0.029	0.001	0.019	0.008	0.008	0.005	0.005	1
#42	22	16:08 - 09:23	0.001	0.011	0.001	0.012	0.007	0.008	0.001	0.004	2.5

TABLE # 7a (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE August 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			H ₂ S		SO ₂		H ₂ S	SO ₂	H ₂ S	SO ₂	
			Min.	Max.	Min.	Max.					Min.
Thunder Bay #43	23	11:00 - 16:00	0.002	0.014	0.003	0.012	0.007	0.007	0.006	0.005	1
#44	23	22:09 - 09:19	0.001	0.003	0.004	0.014	0.002	0.012	0.001	0.007	2
#45	24	11:24 - 14:39	0.001	0.031	0.003	0.016	0.005	0.014	0.004	0.008	2.5
#46	24	14:57 - 21:42	0.001	0.002	0.002	0.047	0.002	0.039	0.001	0.012	2.5
#48	24	22:27 - 08:42	0.001	0.003	0.002	0.013	0.002	0.011	0.001	0.004	1.5
#50	25	23:28 - 09:43	0.001	0.053	0.001	0.020	0.007	0.009	0.004	0.001	1
#52	Sept. 2	16:56 - 02:11	0.001	0.001	0.003	0.008	0.001	0.007	0.001	0.005	5
#53	3	17:45 - 08:45	0.001	0.018	0.003	0.333	0.008	0.14	0.002	0.011	2.5
#54	4	15:58 - 16:58	0.003	0.016	0.004	0.009	0.011	0.007	0.007	0.006	2.5
#55	4	17:27 - 08:57	0.001	0.003	0.002	0.029	0.002	0.009	0.001	0.004	2.5
#56	5	14:08 - 16:53	0.001	0.036	0.001	0.016	0.023	0.013	0.012	0.007	2.5
#57	5	18:02 - 23:17	0.001	0.004	0.001	0.004	0.004	0.002	0.002	0.001	2.5
#58	6	00:07 - 08:52	0.001	0.003	0.001	0.025	0.002	0.007	0.001	0.001	1.5

COMMENTS;

TABLE # 7a (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE Sept. 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			H ₂ S		SO ₂		H ₂ S	SO ₂	H ₂ S	SO ₂	
			Min.	Max.	Min.	Max.					Min.
Thunder Bay #59	6	10:34 - 12:34	0.006	0.016	0.009	0.021	0.017	0.014	0.009	0.013	2.5
#60	6	13:16 - 15:31	0.002	0.006	0.007	0.016	0.005	0.014	0.003	0.010	1
#61	6	15:48 - 17:48	0.003	0.035	0.002	0.022	0.023	0.015	0.011	0.007	1.5
#62	6	18:44 - 21:14	0.007	0.072	0.001	0.005	0.060	0.003	0.034	0.002	1.5
#63	6	21:40 - 09:10	0.001	0.006	0.001	0.009	0.005	0.003	0.001	0.002	2.5
#64	7	10:50 - 16:35	0.007	0.057	0.003	0.012	0.026	0.007	0.021	0.005	1.5
#65	7	17:28 - 18:58	0.003	0.009	0.004	0.008	0.007	0.007	0.005	0.006	1.5
#66	7	20:05 - 09:35	0.001	0.004	0.003	0.020	0.003	0.008	0.001	0.006	1.5
#67	8	10:14 - 13:14	0.008	0.060	0.006	0.018	0.044	0.012	0.023	0.008	1.5
#68	8	13:41 - 21:26	0.001	0.014	0.003	0.013	0.008	0.006	0.003	0.005	1.5
#69	8	21:40 - 09:25	0.001	0.041	0.003	0.018	0.033	0.007	0.008	0.005	2.5
#70	9	11:59 - 15:14	0.002	0.049	0.002	0.011	0.022	0.007	0.015	0.004	1.5
#71	9	15:23 - 16:23	0.004	0.016	0.002	0.005	0.009	0.004	0.007	0.003	1.5
#72	9	16:52 - 07:22	0.001	0.003	0.001	0.009	0.002	0.005	0.001	0.003	2.5

COMMENTS:

TABLE # 7bAMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			NO _x		O ₃						Min.
			Min.	Max.	Min.	Max.	NO _x	O ₃	NO _x	O ₃	
Thunder Bay #1	July 31	16:27 - 07:12	0.010	0.384	0.001	0.038	0.13	0.035	0.065	0.016	1
#2	Aug. 1	14:40 - 16:40	0.011	0.067	0.022	0.046	0.032	0.044	0.025	0.038	1.5
#3	1	18:09 - 08:54	0.001	0.379	0.001	0.065	0.112	0.060	0.058	0.030	1.5
#4	2	16:09 - 21:54	0.020	0.149	0.020	0.047	0.078	0.045	0.046	0.033	2.5
#5	2	21:58 - 08:58	0.019	0.077	0.013	0.023	0.049	0.022	0.031	0.018	2.5
#6	3	12:51 - 15:21	0.033	0.381	0.019	0.030	0.14	0.026	0.100	0.024	2.5
#7	3	16:28 - 21:58	0.010	0.187	0.016	0.036	0.081	0.033	0.039	0.028	1.5
#8	3	22:32 - 11:47	0.035	0.365	0.016	0.037	0.14	0.030	0.085	0.025	1.5
#9	4	16:52 - 06:52	0.001	0.243	0.001	0.056	0.15	0.055	0.074	0.039	2.5
#10	5	15:52 - 22:07	0.017	0.188	0.021	0.050	0.090	0.047	0.046	0.036	2.5
#11	5	22:45 - 00:30	0.024	0.169	0.006	0.022	0.093	0.019	0.062	0.015	2.5
#12	6	00:42 - 08:42	0.021	0.022	0.001	0.013	0.12	0.010	0.041	0.004	2.5
#14	6	21:03 - 09:03	0.022	0.366	0.001	0.021	0.16	0.018	0.076	0.003	2.5

COMMENTS;

TABLE # 7b (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE Aug. 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME Min.
			NO _x		O ₃		NO _x	O ₃	NO _x	O ₃	
Thunder Bay #15	7	15:35 - 17:35	0.027	0.140	0.060	0.089	0.076	0.078	0.064	0.074	1
#16	7	18:01 - 20:31	0.028	0.161	0.039	0.099	0.11	0.082	0.083	0.075	1
#17	10	14:42 - 16:42	0.011	0.067	0.033	0.047	0.054	0.044	0.033	0.040	2.5
#18	10	17:34 - 21:34	0.008	0.374	0.029	0.053	0.039	0.046	0.025	0.042	1
#19	10	22:33 - 09:03	0.013	0.324	0.001	0.051	0.17	0.039	0.081	0.009	2.5
#20	11	12:44 - 17:24	0.019	0.132	0.042	0.069	0.055	0.064	0.040	0.055	2.5
#21	11	17:58 - 09:13	0.021	0.199	0.001	0.058	0.11	0.055	0.022	0.053	2.5
#22	12	15:10 - 22:10	0.014	0.136	0.007	0.082	0.098	0.070	0.052	0.054	1
#23	12	22:14 - 08:59	0.030	0.565	0.001	0.054	0.20	0.049	0.131	0.008	2.5
#24	13	14:52 - 17:37	0.009	0.181	0.010	0.038	0.063	0.030	0.043	0.023	1
#25	13	19:12 - 08:57	0.015	0.182	0.004	0.049	0.11	0.046	0.045	0.029	2.5
#26	14	10:56 - 13:11	0.020	0.112	0.043	0.067	0.053	0.061	0.043	0.059	2.5
#27	14	13:38 - 15:38	0.021	0.427	0.030	0.078	0.064	0.071	0.050	0.068	1

COMMENTS:

TABLE # 7b (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE August 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME Min.
			NO _x		O ₃		NO _x	O ₃	NO _x	O ₃	
Thunder Bay #28	14	16:01 - 17:01	0.022	0.098	0.061	0.082	0.041	0.075	0.039	0.075	1
#30	17	17:54 - 18:49	0.014	0.082	0.016	0.043	0.041	0.034	0.038	0.032	1
#31	17	19:17 - 22:27	0.027	0.155	0.013	0.038	0.070	0.032	0.052	0.031	2
#32	17	22:49 - 08:49	0.027	0.644	0.001	0.030	0.17	0.025	0.090	0.016	2
#33	18	21:31 - 09:46	0.029	0.312	0.002	0.021	0.15	0.019	0.086	0.012	2.5
#34	19	17:16 - 21:46	0.020	0.322	0.013	0.043	0.056	0.040	0.041	0.032	2.5
#35	19	21:53 - 09:08	0.014	0.295	0.001	0.036	0.076	0.032	0.039	0.011	2.5
#37	20	22:04 - 09:04	0.015	0.392	0.001	0.026	0.31	0.018	0.102	0.004	1.5
#38	21	14:54 - 15:39	0.012	0.101	0.051	0.061	0.023	0.056	0.022	0.056	1.5
#39	21	16:29 - 23:14	0.012	0.123	0.027	0.062	0.040	0.059	0.031	0.052	2.5
#40	21	23:30 - 00:15	0.010	0.053	0.043	0.063	0.023	0.056	0.021	0.056	1.5
#41	22	10:49 - 15:19	0.001	0.259	0.001	0.039	0.057	0.033	0.037	0.028	1
#42	22	16:08 - 09:23	0.002	0.217	0.003	0.038	0.046	0.033	0.019	0.020	2.5

COMMENTS;

TABLE # 7b (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE August 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			NO _x		O ₃		NO _x	O ₃	NO _x	O ₃	
			Min.	Max.	Min.	Max.					Min.
Thunder Bay #43	23	11:00 - 16:00	0.013	0.189	0.011	0.022	0.036	0.018	0.029	0.018	1
#44	23	22:09 - 09:19	0.008	0.343	0.001	0.022	0.11	0.020	0.041	0.014	2
#45	24	11:24 - 14:39	0.019	0.088	0.012	0.026	0.055	0.023	0.046	0.020	2.5
#46	24	14:57 - 21:42	0.021	0.025	0.001	0.022	0.12	0.018	0.073	0.011	2.5
#48	24	22:27 - 08:42	0.017	0.142	0.001	0.010	0.10	0.008	0.037	0.003	1.5
#50	25	23:28 - 09:43	0.014	0.222	0.001	0.035	0.10	0.032	0.044	0.020	1
#52	Sept. 2	16:56 - 02:11	0.002	0.174	0.001	0.037	0.064	0.036	0.025	0.018	5
#53	3	17:45 - 08:45	0.010	0.213	0.001	0.028	0.12	0.027	0.058	0.008	2.5
#54	4	15:58 - 16:58	0.012	0.062	0.027	0.041	0.043	0.038	0.027	0.035	2.5
#55	4	17:27 - 08:57	0.007	0.088	0.003	0.040	0.050	0.037	0.029	0.017	2.5
#56	5	14:08 - 16:53	0.001	0.138	0.001	0.038	0.070	0.028	0.052	0.020	2.5
#57	5	18:02 - 23:17	0.021	0.354	0.001	0.036	0.082	0.032	0.039	0.018	2.5
#58	6	00:07 - 08:52	0.019	0.384	0.001	0.009	0.12	0.005	0.055	0.002	1.5

COMMENTS;

TABLE # 7b (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE Sept. 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME Min.
			NO _x		O ₃		NO _x	O ₃	NO _x	O ₃	
Thunder Bay #59	6	10:34 - 12:34	0.082	0.246	0.002	0.028	0.13	0.014	0.118	0.009	2.5
#60	6	13:16 - 15:31	0.044	0.156	0.025	0.063	0.11	0.050	0.083	0.039	1
#61	6	15:48 - 17:48	0.030	0.211	0.004	0.039	0.092	0.030	0.062	0.015	1.5
#62	6	18:44 - 21:14	0.014	0.093	0.001	0.016	0.031	0.008	0.027	0.004	1.5
#63	6	21:40 - 09:10	0.012	0.242	0.002	0.014	0.037	0.013	0.024	0.008	2.5
#64	7	10:50 - 16:35	0.018	0.639	0.005	0.022	0.078	0.015	0.057	0.011	1.5
#65	7	17:28 - 18:58	0.016	0.100	0.006	0.013	0.040	0.011	0.032	0.010	1.5
#66	7	20:05 - 09:35	0.017	0.210	0.001	0.018	0.11	0.016	0.051	0.011	1.5
#67	8	10:14 - 13:14	0.022	0.541	0.006	0.032	0.12	0.019	0.067	0.016	1.5
#68	8	13:41 - 21:26	0.012	0.127	0.007	0.022	0.048	0.016	0.028	0.013	1.5
#69	8	21:40 - 09:25	0.008	0.320	0.001	0.014	0.21	0.013	0.060	0.007	2.5
#70	9	11:59 - 15:14	0.023	0.151	0.004	0.016	0.057	0.012	0.049	0.010	1.5
#71	9	15:23 - 16:23	0.023	0.110	0.004	0.018	0.050	0.010	0.047	0.010	1.5
#72	9	16:52 - 07:22	0.020	0.255	0.001	0.013	0.099	0.011	0.053	0.004	2.5
COMMENTS:											

TABLE # 7c

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 60-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME Min.
			NO ₂		NO		NO ₂	NO	NO ₂	NO	
Thunder Bay #1	July 31	16:27 - 07:12	0.001	0.333	0.003	0.370	0.034	0.084	0.018	0.050	1
#2	August 1	14:40 - 16:46	0.001	0.054	0.005	0.038	0.019	0.015	0.015	0.012	1.5
#3	1	18:09 - 08:54	0.001	0.213	0.001	0.234	0.043	0.075	0.024	0.036	1.5
#4	2	16:09 - 21:49	0.001	0.082	0.005	0.158	0.029	0.049	0.018	0.030	2.5
#5	2	21:58 - 08:58	0.001	0.060	0.013	0.068	0.012	0.032	0.009	0.022	2.5
#6	3	12:51 - 15:21	0.001	0.350	0.013	0.133	0.043	0.082	0.039	0.065	2.5
#7	3	16:28 - 22:10	0.001	0.119	0.006	0.108	0.022	0.047	0.015	0.024	1.5
#8	3	22:32 - 11:47	0.001	0.339	0.023	0.269	0.058	0.100	0.034	0.057	1.5
#9	4	16:52 - 06:52	0.001	0.229	0.001	0.164	0.053	0.090	0.028	0.051	2.5
#10	5	15:52 - 22:02	0.001	0.133	0.010	0.183	0.026	0.060	0.013	0.037	2.5
#11	5	22:45 - 00:03	0.001	0.077	0.011	0.125	0.033	0.051	0.028	0.015	2.5
#12	6	00:42 - 08:42	0.001	0.170	0.012	0.369	0.042	0.075	0.015	0.028	2.5
#14	6	21:03 - 09:03	0.001	0.141	0.010	0.324	0.039	0.096	0.023	0.053	2.5
COMMENTS;											

TABLE # 7c (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE August 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 60-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME Min.
			NO ₂		NO		NO ₂	NO	NO ₂	NO	
Thunder Bay #15	7	15:35 - 17:40	0.001	0.149	0.007	0.094	0.058	0.022	0.056	0.020	1
#16	7	18:01 - 20:31	0.011	0.187	0.009	0.066	0.075	0.046	0.060	0.034	1
#17	10	14:42 - 16:42	0.003	0.031	0.006	0.040	0.017	0.028	0.014	0.019	2.5
#18	10	17:34 - 21:34	0.001	0.425	0.004	0.115	0.019	0.023	0.014	0.013	1
#19	10	22:33 - 09:03	0.001	0.133	0.008	0.427	0.050	0.141	0.033	0.051	2.5
#20	11	12:24 - 17:24	0.001	0.413	0.001	0.120	0.067	0.023	0.035	0.014	2.5
#21	11	17:58 - 09:13	0.001	0.117	0.010	0.122	0.065	0.051	0.032	0.025	2.5
#22	12	15:10 - 22:10	0.001	0.109	0.001	0.080	0.061	0.054	0.033	0.025	1
#23	12	22:14 - 08:59	0.001	0.352	0.001	0.299	0.107	0.112	0.074	0.067	2.5
#24	13	14:52 - 17:46	0.001	0.155	0.003	0.096	0.028	0.031	0.022	0.024	1
#25	13	19:12 - 08:57	0.001	0.122	0.005	0.082	0.056	0.040	0.031	0.019	2.5
#26	14	10:56 - 13:16	0.005	0.102	0.004	0.039	0.040	0.017	0.035	0.014	2.5
#27	14	13:38 - 15:43	0.001	0.519	0.007	0.294	0.038	0.030	0.036	0.024	1
COMMENTS;											

TABLE # 7c (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE August 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 60-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			NO ₂		NO		NO ₂	NO	NO ₂	NO	Min
			Min.	Max.	Min.	Max.					
Thunder Bay #31	17	19:17 - 22:27	0.001	0.151	0.013	0.155	0.039	0.033	0.031	0.027	2
#32	17	22:49 - 08:49	0.001	0.379	0.016	0.288	0.097	0.074	0.049	0.051	2
#33	18	21:31 - 09:46	0.001	0.301	0.015	0.295	0.062	0.111	0.037	0.059	2.5
#34	19	17:16 - 21:46	0.001	0.204	0.004	0.143	0.035	0.033	0.030	0.019	2.5
#35	19	21:53 - 09:08	0.001	0.207	0.003	0.314	0.028	0.046	0.019	0.011	2.5
#37	20	22:04 - 09:04	0.009	0.102	0.003	0.306	0.073	0.226	0.045	0.004	1.5
#39	21	16:29 - 23:19	0.001	0.139	0.003	0.034	0.037	0.012	0.026	0.009	2.5
#41	22	10:49 - 15:29	0.001	0.303	0.001	0.194	0.028	0.035	0.019	0.026	1
#42	22	16:08 - 09:23	0.001	0.205	0.002	0.323	0.028	0.035	0.011	0.010	2.5
#43	23	11:00 - 16:00	0.001	0.194	0.003	0.191	0.019	0.023	0.017	0.014	1
#44	23	22:09 - 09:09	0.001	0.187	0.002	0.310	0.032	0.062	0.019	0.025	2
#45	24	11:24 - 14:34	0.001	0.060	0.011	0.384	0.023	0.048	0.019	0.032	2.5
#46	24	14:57 - 21:47	0.001	0.175	0.013	0.284	0.039	0.068	0.027	0.050	2.5

COMMENTS;

TABLE # 7c (cont'd)AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE August 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 60-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME Min.
			NO ₂		NO		NO ₂	NO	NO ₂	NO	
Thunder Bay #48	24	22:27 - 08:42	0.003	0.048	0.004	0.127	0.028	0.062	0.023	0.017	1.5
#50	25	23:28 - 09:43	0.001	0.143	0.008	0.216	0.029	0.068	0.015	0.032	1
#52	Sept. 2	16:56 - 02:11	0.001	0.201	0.001	0.116	0.033	0.029	0.018	0.013	5
#53	3	17:45 - 08:45	0.001	0.088	0.005	0.225	0.031	0.106	0.019	0.043	2.5
#55	4	17:27 - 08:57	0.001	0.046	0.002	0.074	0.029	0.026	0.018	0.012	2.5
#56	5	14:08 - 17:03	0.001	0.076	0.001	0.271	0.021	0.066	0.017	0.047	2.5
#57	5	18:02 - 23:22	0.014	0.064	0.004	0.308	0.037	0.039	0.027	0.015	2.5
#58	6	00:07 - 08:52	0.001	0.276	0.005	0.229	0.049	0.083	0.026	0.034	1.5
#59	6	10:34 - 12:44	0.022	0.117	0.024	0.103	0.061	0.070	0.057	0.057	2/5
#60	6	13:16 - 15:36	0.003	0.118	0.010	0.119	0.063	0.048	0.051	0.032	1
#61	6	15:48 - 17:54	0.001	0.187	0.019	0.267	0.036	0.051	0.024	0.047	1.5
#62	6	18:44 - 21:14	0.001	0.074	0.004	0.044	0.013	0.017	0.012	0.014	1.5
#63	6	21:40 - 09:10	0.001	0.009	0.006	0.245	0.003	0.027	0.002	0.016	2.5

COMMENTS;

TABLE # 7c (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF **Great Lakes Forest Products Limited**

[illegible]

TABLE # 7dAMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION O ₃				MAXIMUM 60-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME Min.
			Min.	Max.	Min.	Max.	O ₃		O ₃		
Thunder Bay #1	July 31	16:27 - 07:12	0.001	0.038			0.034		0.016		1
#2	August 1	14:40 - 16:46	0.022	0.046			0.042		0.038		1.5
#3	1	18:09 - 08:54	0.001	0.065			0.058		0.030		1.5
#4	2	16:09 - 21:49	0.020	0.047			0.043		0.033		2.5
#5	2	21:58 - 08:58	0.013	0.023			0.022		0.018		2.5
#6	3	12:51 - 15:21	0.019	0.030			0.025		0.024		2.5
#7	3	16:28 - 22:10	0.016	0.036			0.031		0.028		1.5
#8	3	22:32 - 11:47	0.016	0.037			0.030		0.025		1.5
#9	4	16:52 - 06:52	0.001	0.056			0.054		0.039		2.5
#10	5	15:52 - 22:02	0.021	0.050			0.045		0.036		2.5
#11	5	22:45 - 00:30	0.006	0.022			0.014		0.015		2.5
#12	6	00:42 - 08:42	0.001	0.013			0.009		0.004		2.5
#14	6	21:03 - 09:03	0.001	0.021			0.017		0.003		2.5
COMMENTS;											

TABLE # 7d (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE August 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION O_3				MAXIMUM 60-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME Min.
			Min.	Max.	Min.	Max.	O_3		O_3		
Thunder Bay #15	7	15:35 - 17:40	0.056	0.089			0.075		0.074		1
#16	7	18:01 - 20:31	0.039	0.099			0.082		0.075		1
#17	10	14:42 - 16:42	0.033	0.047			0.043		0.040		2.5
#18	10	17:34 - 21:34	0.029	0.053			0.045		0.042		1
#19	10	22:33 - 09:03	0.001	0.051			0.033		0.009		2.5
#20	11	12:24 - 17:24	0.042	0.069			0.063		0.055		2.5
#21	11	17:58 - 09:13	0.001	0.058			0.055		0.022		2.5
#22	12	15:10 - 22:10	0.007	0.082			0.068		0.054		1
#23	12	22:14 - 08:59	0.001	0.054			0.046		0.008		2.5
#24	13	14:52 - 17:46	0.010	0.038			0.026		0.023		1
#25	13	19:12 - 08:57	0.004	0.049			0.045		0.029		2.5
#26	14	10:56 - 13:16	0.043	0.068			0.059		0.059		2.5
#27	14	13:38 - 15:43	0.030	0.078			0.070		0.068		1
COMMENTS;											

TABLE # 7d (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE August 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 60-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME Min.
			O ₃		Min.	Max.	O ₃		O ₃		
			Min.	Max.							
Thunder Bay #31	17	19:17 - 22:27	0.013	0.038			0.032		0.031		2
#32	17	22:49 - 08:49	0.001	0.030			0.024		0.016		2
#33	18	21:31 - 09:46	0.002	0.021			0.018		0.012		2.5
#34	19	17:16 - 21:46	0.013	0.043			0.039		0.032		2.5
#35	19	21:53 - 09:08	0.001	0.036			0.028		0.011		2.5
#37	20	22:04 - 09:04	0.001	0.026			0.012		0.004		1.5
#39	21	16:29 - 23:19	0.027	0.062			0.056		0.052		2.5
#41	22	10:49 - 15:29	0.001	0.039			0.033		0.028		1
#42	22	16:08 - 09:23	0.003	0.038			0.033		0.020		2.5
#43	23	11:00 - 16:00	0.011	0.022			0.019		0.018		1
#44	23	22:09 - 09:09	0.001	0.022			0.019		0.014		2
#45	24	11:24 - 14:34	0.012	0.026			0.022		0.020		2.5
#46	24	14:57 - 21:47	0.001	0.022			0.017		0.011		2.5
COMMENTS;											

TABLE # 7d (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

MONITORING LOCATION / NUMBER	DATE August 1978	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION O ₃				MAXIMUM 60-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME Min.
			Min.	Max.	Min.	Max.	O ₃		O ₃		
Thunder Bay#48	24	22:27 - 08:42	0.001	0.010			0.007		0.003		1.5
#50	25	23:28 - 09:43	0.001	0.035			0.032		0.020		1
#52	Sept. 2	16:56 - 02:11	0.001	0.037			0.034		0.018		5
#53	3	17:45 - 08:45	0.001	0.028			0.026		0.008		2.5
#55	4	17:27 - 08:57	0.003	0.040			0.036		0.017		2.5
#56	5	14:08 - 17:03	0.001	0.038			0.028		0.020		2.5
#57	5	18:02 - 23:22	0.001	0.036			0.032		0.018		2.5
#58	6	00:07 - 08:52	0.001	0.009			0.004		0.002		1.5
#59	6	10:34 - 12:44	0.002	0.028			0.014		0.009		2.5
#60	6	13:16 - 15:36	0.025	0.063			0.046		0.039		1
#61	6	15:48 - 17:54	0.004	0.039			0.025		0.015		1.5
#62	6	18:44 - 21:14	0.001	0.016			0.007		0.004		1.5
#63	6	21:40 - 09:10	0.002	0.014			0.012		0.008		2.5
COMMENTS;											

TABLE # 7d (cont'd)

AMBIENT AIR SURVEY IN Thunder Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Great Lakes Forest Products Limited

[illegible]

Units - PPM

[illegible]

COMMENTS:

8b

Red Rock

Units - PPM

Domtar Packaging Ltd.

[illegible]

COMMENTS :

TABLE # 8c

AMBIENT AIR SURVEY IN Red Rock

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Domtar Packaging Limited

[illegible]

COMMENTS;

TABLE # 8c

AMBIENT AIR SURVEY IN Red Rock

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Domtar Packaging Limited

[illegible]

COMMENTS;

Units - PPM

[illegible]

9b

Marathon

1213M

American Can Canada Inc.

-106-

Units - PPM

[illegible]

COMMENTS:

PAGE # 10d

AMBIENT AIR SURVEY IN Terrace Bay

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF Kimberly-Clark of Canada, Ltd.

[illegible]

$\rho = 0.999999999$

Table # 11

HI-VOL ANALYSIS FOR Thunder Bay, 1978

SITE	HI-VOL	LOCATION	DATE	MICROGRAMS/m ³							Sample	WIND
ID	Glass-Fibre Filter # 600--- Columns 1&2	DESCRIPTION	August	1 T.S.P.	2 Fe	Delbag Filter # Col. 3-6	3 Si	4 SO ₄	5 NO ₃	6 Fe	Time (Hrs.)	SPEED (km/hr)
H1	228	Trailer Park (T.P.)	1	32	1.0						24	S
H2	229	M. Tocheri (M.T.)		40	1.5						"	8
H3	230	Dow Chemical (D.C.)		35	1.3	T1	9.6	4.7	0.0	1.4	"	
H4	231	Canadian Car (C.C.)		63	2.4	T2	5.5	3.6	0.1	1.5	"	
H5	232	St. Anne's School (S.A.S.)		21	1.0						"	
		Daily Average		38	1.4							
H1	233	T.P.	2	27	1.7						"	WSW
H3	234	D.C.		39	3.0	T3	14.7	1.1	0.0	3.1	"	17
H2	235	M.T.		23	1.4						"	
H4	236	C.C.		28	1.7	T4	13.4	2.5	0.0	1.9	"	
		Daily Average		29	2.0							
H1	238	T.P.	3	32	1.2						"	W
H2	240	M.T.		37	1.7						"	16
H3	241	D.C.		117	6.9	T5	35.0	1.5	0.0	9.6	"	
H4	242	C.C.		67	3.1	T6	6.8	3.2	0.0	2.0	"	
H5	243	S.A.S.		9	0.7						"	

Table #11 (cont'd)

HI-VOL ANALYSIS FOR Thunder Bay, 1978

SITE ID	HI-VOL Glass-Fibre Filter # 600--- Columns 1&2	LOCATION	DATE	MICROGRAMS/m ³							Sample Time (Hrs.)	WIND Dir. Speed (km/hr)
		DESCRIPTION	August	1 T.S.P.	2 Fe	Delbag Filter # Col. 3-6	3 Si	4 SO ₄ ⁼	5 NO ₃	6 Fe		
		Daily Average	3	52	2.7							W/16
H1	244	T.P.	4	41	1.9						24	WSW
H2	245	M.T.		54	2.1						"	19
H3	246	D.C.		272	18.7	T7	33.8	6.1	0.9	14.1	"	
H4	247	C.C.		152	5.5	T8	25.7	8.1	1.2	4.2	"	
H5	248	S.A.S.		21	1.7						"	
		Daily Average		108	6.0							
H1	251	T.P.	5	47	2.1						"	W
H2	252	M.T.		95	3.9						"	15
H3	253	D.C.		72	3.1	T9	14.3	1.4	0.0	3.0	"	
H4	254	C.C.		54	2.0	T10	4.1	1.9	0.0	1.4	"	
H5	255	S.A.S.		13	0.9						"	
		Daily Average		56	2.4							
H1	256	T.P.	6	35	2.0						"	E
H2	257	M.T.		79	3.5						"	9
H4	258	C.C.		58	2.8	T11	6.7	2.3	0.0	1.9	"	

Table #11 (cont'd)

HI-VOL ANALYSIS FOR Thunder Bay, 1978

SITE	HI-VOL	LOCATION	DATE	MICROGRAMS/m ³							Sample	WIND
ID	Glass-Fibre Filter # 600--- Columns 1&2	DESCRIPTION	August	1 T.S.P.	2 Fe	Delbag Filter # Col. 3-6	3 Si	4 SO ₄ ⁼	5 NO ₃	6 Fe	Time (Hrs)	Dir. Speed (km/hr)
H5	259	S.A.S.	6	13	1.0						24	E
		Daily Average		46	2.3							9
H1	260	T.P.	7	79	2.6						"	SW
H2	261	M.T.		95	3.6						"	11
H3	262	D.C.		187	6.2	T12	36.4	17.9	3.9	6.8	"	
H4	263	C.C.		132	4.4	T13	23.0	7.4	1.7	3.3	"	
H5	264	S.A.S.		26	1.1						"	
		Daily Average		104	3.6							
H2	266	M.T.	8	95	4.5						"	W
H3	267	D.C.		196	11.5	T14	51.6	4.3	0.0	10.5	"	15
H4	268	C.C.		74	3.0						"	
		Daily Average		122	6.3							
H2	271	M.T.	9	140	6.2						"	W
H3	272	D.C.		296	18.5	T16	67.7	2.8	0.5	16.3	"	13
H4	273	C.C.		131	7.5						"	
H5	274	S.A.S.		18	1.3						"	

Table #11 (cont'd)

HI-VOL ANALYSIS FOR Thunder Bay , 19 78

SITE ID	HI-VOL Glass-Fibre Filter # 600--- Columns 1&2	LOCATION	DATE	MICROGRAMS/m ³							Sample Time	WIND Dir.
		DESCRIPTION	August	1 T.S.P.	2 Fe	Delbag Filter # Col. 3-6	3 Si	4 SO ₄	5 NO ₃	6 Fe	(Hrs.)	Speed (km/hr)
		Daily Average		177	8.4							W/13
H1	275	T.P.	10	88	4.3						24	S
H2	276	M.T.		134	6.4						"	8
H3	277	D.C.		128	5.5	T17	75.7	6.5	0.8	5.1	"	
H4	278	C.C.		126	7.8	T18	25.1	5.2	0.8	5.2	"	
H5	279	S.A.S.		28	1.2						"	
		Daily Average		101	5.0							
H1	280	T.P.	11	73	2.0						"	SW
H2	281	M.T.		149	5.2						"	8
H3	282	D.C.		165	6.9	T19	25.1	12.5	2.8	8.8	"	
H4	297	C.C.		117	3.6	T20	15.3	8.5	1.6	3.5	"	
H5	298	S.A.S.		29	1.0						"	
		Daily Average		133	3.7							
H1	299	T.P.	12	86	3.7						"	SW
H2	300	M.T.		124	4.4						"	8
H3	301	D.C.		266	11.0	T21	72.7	18.9	1.0	18.9	"	

Table #11 (cont'd)

HI-VOL ANALYSIS FOR Thunder Bay, 19 78

SITE	HI-VOL	LOCATION	DATE	MICROGRAMS/m ³							Sample	WIND
ID	Glass-Fibre Filter # 600--- Columns 1&2	DESCRIPTION	August	1 T.S.P.	2 Fe	Delbag Filter # Col. 3-6	3 Si	4 SO ₄ ⁼	5 NO ₃	6 Fe	Time (Hrs.)	Speed (km/hr)
H4	302	C.C.	12	161	7.7	T22	31.1	13.6	1.1	6.7	24	SW
H5	303	S.A.S.		31	2.0						"	8
		Daily Average		134	5.8							
H1	304	T.P.	13	41	0.7						"	E
H2	305	M.T.		107	2.1						"	9
H4	306	C.C.		53	2.2	T23	7.6	9.3	0.0	1.7	"	
H5	307	S.A.S.		18	0.7						"	
		Daily Average		55	1.4							
H1	308	T.P.	14	67	1.8						"	SSW
H2	309	M.T.		92	3.1						"	15
H3	310	D.C.		137	3.8	T24	21.5	22.1	1.4	4.4	"	
H4	311	C.C.		83	3.0	T25	11.7	14.2	0.0	2.4	"	
H5	312	S.A.S.		30	1.1						"	
		Daily Average		82	2.6							
H1	313	T.P.	15	51	0.9						"	E
H2	314	M.T.		105	2.7						"	10

Table #11 (cont'd)

HI-VOL ANALYSIS FOR Thunder Bay, 19 78

SITE	HI-VOL	LOCATION	DATE	MICROGRAMS/m ³							Sample Time	WIND Dir.
ID	Glass-Fibre Filter # 600--- Columns 1&2	DESCRIPTION	August	1 T.S.P.	2 Fe	Delbag Filter # Col. 3-6	3 Si	4 SO ₄ ⁼	5 NO ₃	6 Fe	(Hrs.)	Speed (km/hr)
H3	315	D.C.	15	59	1.2	T26	4.6	12.8	0.0	1.0	24	E
H4	316	C.C.		55	1.4	T27	3.1	15.7	0.0	1.1	"	10
H5	317	S.A.S.		18	0.3						"	
		Daily Average		58	1.3							
H1	318	T.P.	16	46	1.2						"	NNW
H2	319	M.T.		65	3.8						"	10
H3	320	D.C.		41	2.2	T28	5.5	0.8	0.0	1.6	"	
H4	321	C.C.		17	1.5	T29	2.3	0.5	0.0	0.9	"	
H5	322	S.A.S.		7	0.3						"	
		Daily Average		35	1.8							
H1	323	T.P.	17	33	1.0						26	ESE
H2	324	M.T.		137	6.4						25	11
H3	325	D.C.		52	0.6	T30	3.8	3.6	0.0	1.7	26	
H4	326	C.C.		51	1.1	T31	4.4	2.8	0.1	2.2	26	
H5	327	S.A.S.		10	0.5						25.5	
		Daily Average		57	1.9							

Table #11 (cont'd)

HI-VOL ANALYSIS FOR Thunder Bay, 1978

SITE	HI-VOL	LOCATION	DATE	MICROGRAMS/m ³							Sample Time (Hrs.)	WIND Dir. Speed (km/hr)
				1 T.S.P.	2 Fe	Delbag Filter # Col. 3-6	3 Si	4 SO ₄ ⁼	5 NO ₃	6 Fe		
ID	Glass-Fibre Filter # 600--- Columns 1&2	DESCRIPTION	August									
H1	328	T.P.	18	37	2.7						24	W
H3	330	D.C.		131	8.0	T32	6.2	1.3	0.0	2.2	"	12
H4	331	C.C.		70	2.7	T33	6.1	5.1	0.5	2.3	"	
H5	332	S.A.S.		8	0.6						"	
		Daily Average		62	3.5							
H2	329	M.T.	19	44	2.2						"	W
H1	333	T.P.		43	1.6						"	14
H3	334	D.C.		120	6.3						"	
H4	335	C.C.		55	2.5	T34	4.3	1.4	0.3	1.7	"	
H5	336	S.A.S.		14	1.1						"	
		Daily Average		55	2.7							
H1	337	T.P.	20	62	3.0						"	S
H2	338	M.T.		89	4.2						"	10
H4	339	C.C.		91	4.2	T35	9.9	4.2	1.0	3.5	"	
H5	340	S.A.S.		27	1.2						"	
		Daily Average		67	3.2							

Table #11 (cont'd)

HI-VOL ANALYSIS FOR Thunder Bay, 1978

SITE	HI-VOL	LOCATION	DATE	MICROGRAMS/m ³							Sample Time	WIND Dir.
ID	Glass-Fibre Filter # 600--- Columns 1&2	DESCRIPTION	August	1 T.S.P.	2 Fe	Delbag Filter # Col. 3-6	3 Si	4 SO ₄ ⁼	5 NO ₃	6 Fe	(Hrs.)	Speed (km/hr)
H1	341	T.P.	21	57	1.3						24	S
H2	342	M.T.		47	1.7						"	10
H3	343	D.C.		109	3.2	T36	6.2	7.3	0.6	1.2	"	
H4	344	C.C.		59	2.4	T37	8.0	6.5	0.4	1.8	"	
H5	345	S.A.S.		20	1.0						"	
		Daily Average		58	1.9							
H2	347	M.T.	22	122	4.3						"	WNW
H3	348	D.C.		22	1.1	T38	4.3	0.9	0.0	1.2	"	14
H4	349	C.C.		28	1.4	T39	1.5	1.0	0.0	1.2	"	
H5	350	S.A.S.		6	0.3						"	
		Daily Average		45	1.8							
H1	451	T.P.	23	14	0.7						21	E
H2	452	M.T.		81	3.3						24	19
H3	453	D.C.		34	2.3	T40	4.4	1.7	0.0	1.7	"	
H4	454	C.C.		35	1.7	T41	2.8	2.1	0.0	1.4	25	
H5	455	S.A.S.		9	0.6						"	

HI-VOL ANALYSIS FOR Thunder Bay , 19 78

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TABLE #12

TRACOR SAMPLING STATISTICS

Date	Area	Sample#	Location	Sampling Time ON-OFF	Comments
Sept. 5	Thunder Bay	1	near HWY #61 & Broadway	14:10 - 14:40	approx 1 km & 305 deg/source
		2	near HWY #61 & Broadway	15:10 - 15:50	approx 1 km & 305 deg/source
		3	near HWY #61 & Broadway	16:03 - 16:33	approx 1 km & 305 deg/source
		4	near HWY #61 & Broadway	16:34 - 17:05	approx 1 km & 305 deg/source
Sept. 6	Thunder Bay	5	Montreal & Neebing	10:25 - 10:55	approx 1 km & 005 deg/source
		6	Montreal & Neebing	12:10 - 12:40	approx 1 km & 005 deg/source
		7	Dow parking lot	13:05 - 13:40	approx 0.2 km & 090 deg/source
		11	HWY #61, 0.5 km S of Broadway	15:25 - 15:55	approx 0.8 km & 275 deg/source
		12	HWY #61, 0.5 km S of Broadway	15:29 - 15:59	approx 0.8 km & 275 deg/source
		13	Dow parking lot	15:15 - 15:45	approx 0.2 km & 090 deg/source
		14	HWY #61, 0.5 km S of Broadway	17:10 - 17:40	approx 0.8 km & 275 deg/source
		15	HWY #61, 0.5 km NE of HWY #61B	17:15 - 17:45	approx 1.2 km & 230 deg/source
		17	HWY #61, 0.2 km S of Broadway	18:45 - 19:15	approx 0.9 km & 295 deg/source
		18	HWY #61, 0.6 km S of Broadway	18:48 - 19:18	approx 0.8 km & 270 deg/source
Sept. 7	Thunder Bay	19	HWY #61 & Broadway, fence	11:10 - 11:40	approx 1 km & 305 deg/source
		20	Victor St. at Bottom of Hill	11:20 - 11:50	approx 2 km & 265 deg/source
		21	HWY #61 & Broadway, fence	14:10 - 14:40	approx 1km & 305 deg/source
		22	Cemetery gates	14:15 - 14:45	approx 1.1 km & 305 deg/source
		23	HWY #61, 0.7 km S of Broadway	15:15 - 15:45	approx 0.8 km & 265 deg/source
		24	Victor St., Bottom of Hill	15:20 - 15:50	approx 2 km & 265 deg/source
		25	at Transmode site near Riverdale	17:45 - 18:15	approx 3 km & 250 deg/source
		26	junction near Riverdale & Riverdale N.	17:50 - 18:20	approx 3 km & 250 deg/source
Sept. 8	Thunder Bay	27	HWY #61, 0.1 km S of Broadway	11:05 - 11:35	approx 1 km & 290 deg/source
		28	HWY #61, 0.2 km S of Broadway	11:15 - 11:45	approx 0.9 km & 295 deg/source
		29	Broadway, Cemetary	13:35 - 14:05	approx 1 km & 305 deg/source
		30	HWY #61 & Broadway, NE corner	13:40 - 14:10	approx 1 km & 305 deg/source
		31	HWY #61 & Broadway, NE corner	16:13 - 16:43	approx 1 km & 305 deg/source
		32	GLFP wood yard	16:20 - 16:50	approx 0.1 km & 270 deg/source
		33	HWY #61, 0.1 km N of Broadway	16:25 - 16:55	approx 1.0 km & 305 deg/source

Table #12 (cont'd)
TRACOR SAMPLING STATISTICS

Date	Area	Sample#	Location	Sampling Time ON - OFF	Comments
Sept.11	Marathon	1	base of effluent drain (x4445-y9550)	11:30 - 12:00	approx. 0.6 km & 180 deg/source
		2	0.5Km E of effluent drain (x4465-y9525)	12:00 - 12:30	approx. 0.9 km & 165 deg/source
		3	(x4490-y9500) Tank farm	12:30 - 13:00	approx. 1.2 km & 160 deg/source
Sept.13	Marathon	1	directly below stack (digester) (x4450-69600)	10:30 - 11:00	approx. 0.1 km & 160 deg/source
		2	on plant property, halfway up Peninsula Hill (x4430-69595)	11:00 - 11:30	approx. 0.3 km & 220 deg/source
		3	drainage ditch (x4450-y9580)	11:30 - 12:00	approx. 0.4 km & 170 deg/source
Sept.12	Red Rock	1	SW fence of plant (x0815-y2065)	11:50 - 12:20	approx. 0.5 km & 230 deg/source
		2	SW fence of plant (x0815-y2065)	11:55 - 12:25	approx. 0.5 km & 230 deg/source
		3	SW fence of plant (x0815-y2065)	14:50 - 15:20	approx. 0.5 km & 230 deg/source
Sept.13	Red Rock	1	Hudson's Bay (school fence) (x0750-y2140)	10:10 - 10:40	approx. 1.1 km & 290 deg/source
		2	plant fence (x0805-y2125)	10:15 - 10:45	approx. 0.6 km & 290 deg/source
		3	plant fence (0810-y2130)	10:50 - 11:20	approx. 0.6 km & 295 deg/source
		4	Brompton Rd. & Taylor Ave. (x0785-y2165)	11:55 - 12:25	approx. 1.0 km & 310 deg/source
		5	on Red Rock Rd. (near #1 crossroad) (x0585-y2220)	13:40 - 14:10	approx. 3.0 km & 290 deg/source
Sept.12	Terrace Bay	1	Bridge W of Terrace Bay (x4915-y4035)	18:00 - 18:30	approx. 1.4 km & 210 deg/source

TABLE #13
STATISTICAL SUMMARY OF
SULPHUR ANALYSIS
(units - ppb)

Location	# of Samples	H ₂ S (& COS)	MeSH	EtSH (& (CH ₃) ₂ S)
1) Thunder Bay - Average	29	2.0	5.8	8.6
Relative Concentration		12%	35%	52%
2) Red Rock - Average	8	48.3	5.3	2.5
Relative Concentration		86%	9%	4%
3) Marathon - Average	6	50.7	45.8	27.9
Relative Concentration		41%	37%	22%
4) Terrace Bay - Average	1	1.5	2.5	2.5
Relative Concentration		23%	38%	38%
5) Overall Averages	44	17.1	11.1	10.0
Relative Concentration		45%	29%	26%

TABLE #14
SULPHUR ANALYSIS RESULTS

Date	Area	Sample #	Concentrations-ppb				
			H ₂ S	MeSH	EtSH	CS ₂	SO ₂
Sept. 5	Thunder Bay	1	1-2	5	10-15		
		2	2	0-5	30		
		3	1	-	-		
		4	1-2	-	-		
Sept. 6	Thunder Bay	5	1-2	-	-		
		6	1-2	10	10-15		
		7	1	-	-		
		11	5	10-15	35-40		
		12	3	0-5	20-25		
		13	5	-	-		
		14	1	15	-		
		15	1	-	-		
		17	5	10	20		5
		18	2	15	15		
Sept. 7	Thunder Bay	19	1-2	15-20	15		
		20	1	-	-		
		21	1-2	13	17		
		22	1	-	-		
		23	3	5-10	-		
		24	1-2	-	-		
		25	1-2	-	-		
		26	1-2	-	-		
Sept. 8	Thunder Bay	27	5	15	15		
		28	1-2	-	-		
		29	1-2	-	-		
		30	1-2	-	-		
		31	1-2	-	5-10		
		32	1-2	-	-		
		33	1-2	-	-		
Sept. 11	Marathon	1	100	65-70	50	1.2	20
		2	100	90	60	1.2	-
		3	100	95	50	1.2	20
Sept. 13	Marathon	1	1-2	10	-	-	10
		2	1-2	10	-	-	-
		3	1	-	-	-	-
Sept. 12	Red Rock	1	30-50	10	-	-	-
		2	30-50	10	-	-	-
		3	30-50	10	-	-	-

Table 14 (cont'd)

Date	Area	Sample #	Concentrations - ppb				
			H ₂ S	MeSH	EtSH	CS ₂	SO ₂
Sept. 13	Red Rock	1	5	-	-	-	-
		2	150	-	-	-	-
		3	100	-	-	-	5
		4	10	-	-	-	-
		5	1-2	-	-	-	-
Sept. 12	Terrace Bay	1	1-2	-	-	-	-

N.B. "-" means contaminant was not detected or only a trace was found.